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DEPARTMENT OF AGRICULTURE, BURMA

BULLETIN No. 8, 1912

COTTON-PESTS IN BURMA

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BY

A. BA TE, B.Sc., B.Ag. (Bom.)

Entomologist, Burma, Mandalay

(FIRST REVISED EDITION)

RANGOON

SUPDT., GOVT. PRINTING AND STATIONERY, BURMA

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INTRODUCTION.

The present Bulletin replaces Bulletin No. 8 of 1912.

The area under cotton in Burma at the present time is a record and is well over 500,000 acres. Some years back the area was down to half this and it has fluctuated considerably. The cotton tract occupies very largely the Dry Zone of Upper Burma (mainly Meiktila, Myingyan, Sagaing and Lower Chindwin Districts) with extension into the more northerly districts of Lower Burma (mainly Thayetmyo District) and cotton is a very important money crop in these parts.

Of the cotton area about four-fifths is under the indigenous "Wagale" which is the main cotton crop of Burma and is confined to the Dry Zone. The remainder is made up mostly of "Wagyi", also indigenous, grown in the northerly district of Lower Burma, and there are also small alluvial areas under the exotic Cambodia in the Dry Zone.

Commercially the indigenous cotton is of short staple. Botanically "Wagale" is mostly *Gossypium neglectum*. Tod. sub-var. *burmanicum*, Gammie, or as reclassified recently by Hutchinson and Ghose *G. arboreum* var. *neglectum*, *forma burmanica*. "Wagyi" has been assigned to *G. obtusifolium* Roxb. var. *Nanking* by Gammie or recently by Hutchinson and Ghose to *G. arboreum* var. *typicum*, *forma burmanica*.

The season is the usual one of six months rains (May—October) and six months dry, the latter consisting of a cold weather (November—February) and a hot weather (March-April and part of May). "Wagale" is sown usually in May or very early June, and the bulk of the crop is picked in September and October. "Wagyi" on the other hand is a long-lived crop; picking taking place in February-March. Cambodia is sown in August and picked in February-March.

The conditions under which the crop is grown tend to be precarious and the annual yields to fluctuate greatly, and it is, therefore, fortunate that the hardy indigenous cotton does not suffer from any devastating insect pest. The soils put under cotton in the Dry Zone are usually of the poorer upland type (though recently there has been much expansion into better class soils) and the crop is very subject to the vagaries of the season. In the Dry Zone proper, where temperatures are high and humidity low, the crop depends on an average annual rainfall of about 30 inches (May to November) with wide fluctuations and the distribution is most uncertain, irregular, and even freakish at times. The rainfall in the "Wagyi" tract is higher at about 40 inches.

"Wagale" is usually grown as an annual crop in rotation with others such as early sesamum, beans, groundnuts, sorghum, late sesamum, and fallow, but on stronger and new soils ratooning and continuous cropping are sometimes followed. "Wagyi" is mostly grown under "Taungya" conditions.

With regard to cotton insect pests there are two points which stand out—

(1) The indigenous cottons are very hardly and, while many important cotton pests are present, the damage caused so far has never been too serious except in small areas. It is possible that the hot weather in March-April has a restricting effect on pests, *e.g.*, boll worms.

Consequently, no measures have ever been taken against insect pests already in the country except to discourage ratooning and continuous cropping with cotton, and to encourage good cultivation with rotation and early ploughing up and/or uprooting of the standing cotton as soon as picking is over. Regulations exist to prevent the introduction of pests such as the Mexican boll weevil.

(2) On the other hand superior exotic cottons, especially of the upland American type such as Cambodia feel the full blast of insect attack and suffer very badly. Partly for this reason Cambodia where grown, is sown in August and not at the beginning of the rains as this is found to lessen insect attack. Its worst enemies appear to be the Leaf Roller and Red Cotton Bug or Stainer. Consequent on this cotton improvement has been directed chiefly to selection and hybridising within the indigenous types and also with similar types from India.

Below are given a list of 22 pests and their descriptions follow. Those starred are considered the most common and damaging. It is difficult to call any of them a major pest, but the cotton plant in common, with all other cultivated plants, is attacked by numerous insects at all stages of its growth.

List of Cotton Pests in Burma.

1. *On seedlings*—

(1) * Chafer grubs (*Holotrichia* sp.) cut the seedlings.

(2) * *Brachytrypes portentosus*, Licht. (the large brown cricket) cuts the seedlings.

(3) * A Tenebrionid beetle not described.

2. *On stems and shoots*—

(4) *Earias fabia*, Stoll. the spotted boll-worm which bores the shoots causing them to wilt.

(5) *Alcides mysticus*, Fst. often bores the stem.

(6) *Cerococcus hibisci*, Gr., a brown scale on stems and twigs; is occasionally bad.

(7) *Phenacoccus hirsutus*, Gr. sometimes attacks shoots.

(8) * *Pempheres affinis*, Fst. the cotton stem weevil bores the stem just below the ground level.

3. *On leave*—

(9) Thrips
(10) Jassids
(11) Red mites
} Occur occasionally and are minor pests.

(12) * Aphides Very common.

(13) * *Eriophyes*, sp. a mite lacerating the surface of leaves, is a minor pest.

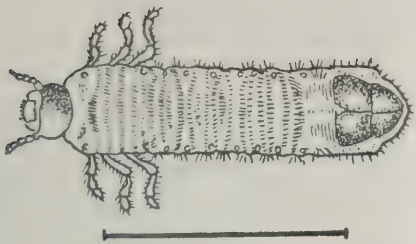
(14) * *Sylepta derogata*, Fst. the cotton leaf roller, is ordinarily a minor pest.

(15) *Cosmophila indica*, Gn. a leaf-eating caterpillar, occurs but very seldom.

(16) *Phycita infusella*, Meyr, a small caterpillar which occasionally occurs on the leaves, rolling them, is a minor pest.

(17) *Aularches miliaris*, Linn. occasionally occurs in large swarms but as a rule the damage done is very restricted.

Plate I.



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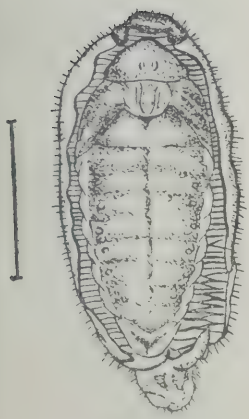

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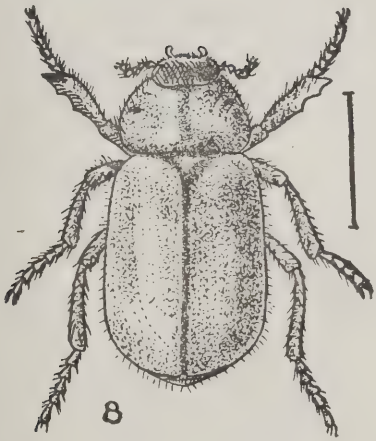

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THE COCKCHAFER

(18) *Diacrisia obliqua*, Wlk., the common hairy caterpillar, occurring occasionally in large numbers, may prove serious sometimes

4. *On flowers and bolls*—

(19) *Earias fabia*, Stoll. and *E. insulana*, Boisd., the spotted boll-worms of cotton. The former is a major pest and the latter a minor pest.

(20) * *Platyedra gossypiella*, Saund., the pink boll-worm of cotton, is a major pest.

(21) * *Dysdercus cingulatus*, Fb., the red cotton bug, is a major pest.

(22) *Oxycarenus lætus*, Kby., the dusky cotton bug, is a minor pest.

Descriptions.

(1) *Chafer grubs* (Pl. I).—These are the larvæ of those chafer beetles which swarm out in the evenings after the first few showers of rain just before the monsoon, many of them being attracted to light. The Burmese name for the grubs is " po-di-gaung." These grubs are found abundantly usually among roots of grasses like millets and sugar-cane.

Life history and habits.—The chafer beetle, " po-kyaing-gaung " swarms out at dusk after showers in April—June settling in large numbers on any convenient crop, like sesamum, groundnut, mulberry, etc., and on avenue trees like the gold mohur (" sein-ban "), the rain-tree (" thinbaw-kokko "), the siris tree (" kokko "), etc. Mating takes place during the night and before dawn they disperse, taking shelter under the soil. The females then lay white round eggs (figs. 1 and 2) among roots of grasses and shrubs. The grubs hatching out from these eggs feed and grow (figs. 3 and 4) and become full grown about September when they go into pupation (figs. 5, 6 and 7) within earthen cells. With the first few showers after the hot months the adult beetles swarm out again to repeat the life cycle.

Food plants.—The grub feeds mainly on roots under-ground, particularly of grasses, but the adult beetle feeds on a good number of plants including sesamum, groundnut, cotton and ornamental plants.

Control.—The breeding places of this insect are varied and numerous, but the grub can do damage only at the place where it happens to be, that is where the female beetle has laid the egg. Therefore ploughing fairly deeply and thoroughly, and harrowing during preparatory tillage operations will do away with many pupæ and grubs in the soil either by crushing them or bringing them up to the surface, exposing them to the attack of their natural enemies.

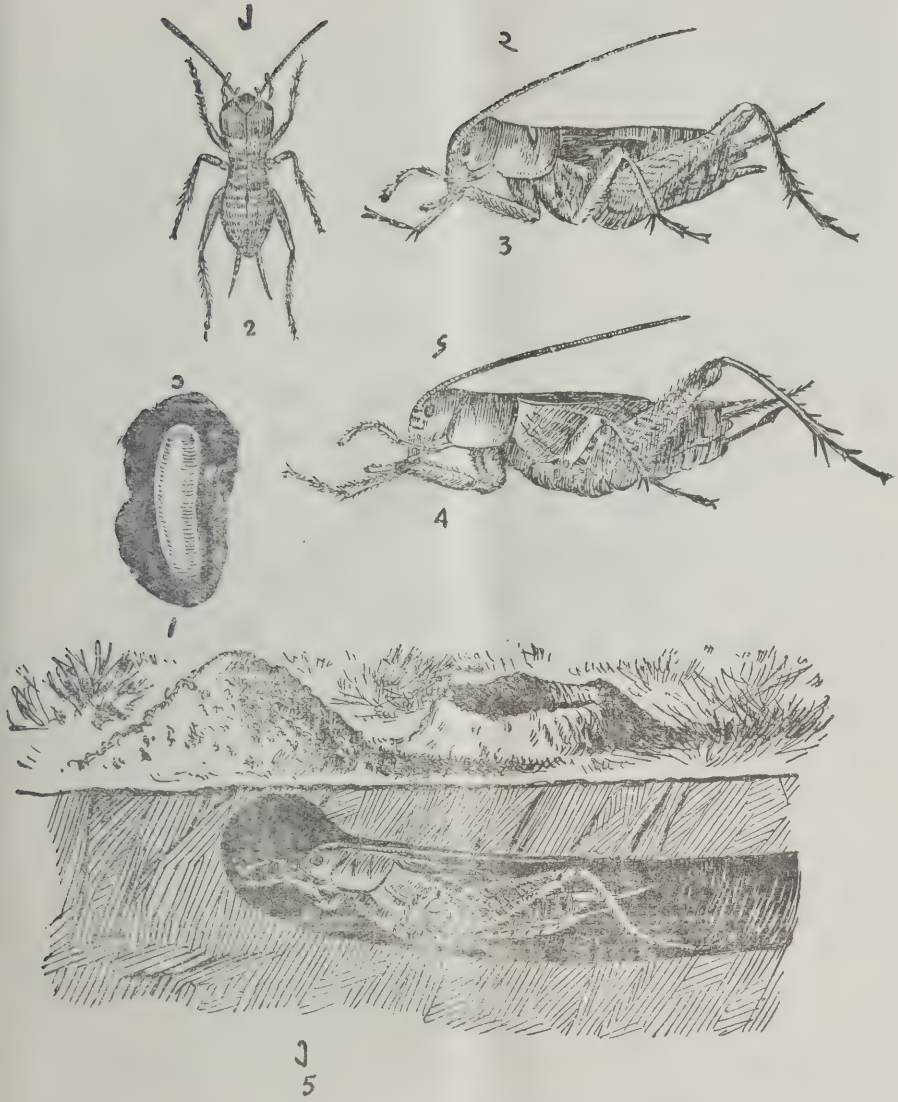
(2) *Brachytrypes portentosus*, Licht (Pl. II).

Life history and habits.—The brown cricket (fig. 4) is also responsible for the seedlings being cut.

The adult comes out between May and July and this is the time the seedlings are cut.

The cricket lives in the hole it digs in the soil (fig. 5). Its presence in a hole is almost always indicated by a small mound of loose earth thrown up at the mouth of the hole. With the beginning of the rains it mates and then about September it lays eggs (fig. 1) in its under-ground burrows. The young wingless ones (fig. 2) hatch out in about a month's time. They grow up gradually with each moulting and become adults in May following. All this time nymphs feed on

Plate II.



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whatever green vegetation is available. With the advance of dry season, their food becomes scarce. Then, when land is being ploughed and harrowed for the cultivation of crops, cotton in this instance, even the coarse plant food on which they have to feed, becomes scarcer still. At this time the cultivator grows his cotton, with the consequence that the cotton seedlings are attacked by the hungry crickets.

Food plants.—All low growing succulent plants are cut by this cricket : tobacco, beans, potato, sesamum, chilli, etc.

Control.—Although not a major pest, this insect proves troublesome occasionally. Many mechanical methods of digging, drowning, trapping, etc., have been advocated but with indifferent results. Poisoned baits have been found fairly successful in "kyun" land, but unfortunately poisons cannot be trusted in the hands of cultivators in general. One part by weight of Paris green with twenty parts by weight of rice bran mixed with five to ten parts by weight of jaggery water kneaded to a light dough make attractive baits, which may be put down about the area to be protected just before dusk. Sodium fluoride can be substituted at half the rate of Paris green.

Even without any poison, the sweetened or flavoured bran, when taken by the insect, will help to minimise the damage to crops in proportion to the amount of this alternative food eaten instead of the crop.

(4) *Earias fabia*, Stoll. (Pl. III) The spotted boll-worm of cotton.—Normally this insect attacks the bolls and buds, but before these are formed on the plants the shoots are bored causing the seedlings to wilt. Later when the plant starts bearing buds and bolls, the attack of this insect will cause the buds to fall, and some bolls will fall and those that do not fall will not open well.

Life history and habits.—The eggs are laid singly on buds, shoots or flowers. The larva (fig. 3) bores into the shoot, or bud, or boll as the case may be. Its presence within is usually indicated by the presence of a little excreta on the mouth of the hole. When full fed after about twenty days, it pupates in a tough cocoon (fig. 7) almost anywhere on the food plant or in the soil. In about another week it comes out as a moth (figs 5 and 6). But near the end of season, the caterpillar does not go into pupation but remains dormant and inactive among the refuse and debris of the crop, or in the soil, only to become active again the next season.

Food plants.—Cotton, *Hibiscus esculentus*, *Abutilon indicum* and other *Malvaceæ*.

Control.—Boll-worms are serious pests in all countries where cotton is grown, and it is possible to minimise damage by checking their increase. The boll-worms multiply more towards the end of the season. Thus their undue increase may be checked by—

(1) cutting all withered shoots as soon as noticed ;
(2) collecting fallen bolls and destroying them along with those bolls which remain unopened on the plant ;
(3) Sowing early and harvesting early, after which the whole crop is uprooted and burnt to do away with all dormant forms of the insect.

(5) *Alcides mysticus*, Fst.—A weevil, the grub of which is known to bore cotton stems about September ; the adult emerging in October. It was recorded once from Mandalay, no serious damage having resulted.

Plate III.

Earias fabia.

Life history and habits.—This insect is practically unknown and the damage due to it is negligible.

(6) *Cerococcus hibisci*, Gr.—This is a bug which has a brownish yellow scaly covering over it. The scale is not unlike a half pea in size and shape, but with short spiney out-growths all over. It is always found in clusters on the branches and shoots, feeding by sucking the juice of its food plants. Usually the annual varieties of cotton are free from this pest but perennial varieties harbour it. When heavily infested the branches turn black with the growth of a fungus, dying off ultimately.

It can spread fairly rapidly, the whole life cycle being passed on the food plant.

Food plants.—Cotton, *Abutilon indicum* ("baukkwe"), *Hibiscus esculentus* ("yonpadi") and *Hibiscus Rosa sinensis* ("khaung-yan") are its host plants.

Control.—(*a*) All badly infested branches should be cut off and burnt.

(*b*) Repeated spraying with a strong solution of soap at the beginning will check its spread. A pound of bar soap boiled in four to six gallons of water makes a good spray for the young scales. Rosin compound will be found to be a better spray.

It is prepared as follows :—

One pound of washing soda is boiled in one gallon of water. While boiling, two pounds of finely powdered common fir-tree rosin is added. The boiling is continued and cold water is added in small quantities from time to time to prevent frothing over, till at last the frothing ceases and the liquid becomes clear. By this time the quantity of the compound will be about three gallons. This solution is diluted with five to seven parts of water for spraying.

(*c*) The weed, *Abutilon indicum* ("baukkwe") should not be allowed to stand near any cotton area.

(7) *Phenacoccus hirsutus*, Gr. is a mealy-bug occurring sometimes on cotton top shoots. Heavily infested shoots and stems look white from a distance. Their presence in several hundreds causes the top shoots to become hard and compact, and the growth is consequently retarded. Thus flowering and bolling may be delayed considerably.

Fortunately, this pest has many parasites that keep it in check.

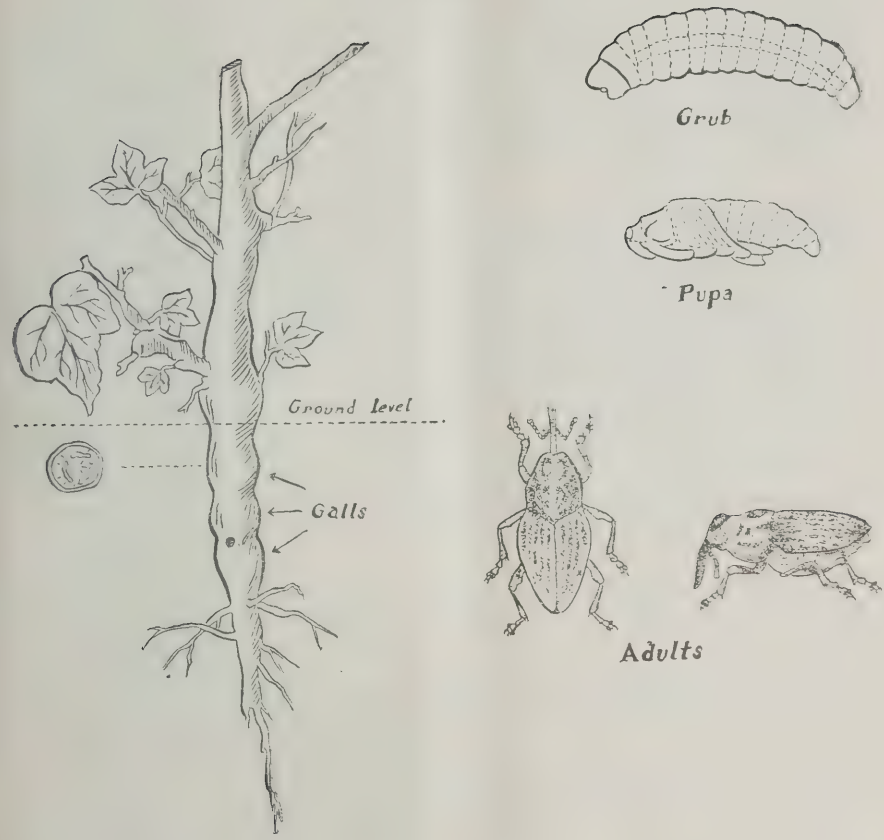
Allowing the crop to remain too long on the ground is one of the contributory causes of the occurrence of this pest.

(8) *Pempheres affinis*, Fst. (Pl. IV) The Cotton Stem Weevil.—It is a curious fact about this insect that widely distant areas may be affected while the intermediate cotton areas remain unattacked.

Nature of attack and damage.—The accompanying illustration gives a fairly good idea of the appearance of the insect in its various stages and the nodular swellings on the attacked plants.

The adult weevil lays eggs in the stem, generally just below the soil. The grub hatches out and bores in the stem. The irritation due to the tunnelling by the grub causes the plant to develop nodular swellings which may be either above the ground level or below. Usually, young seedlings die straight off, but some may survive and grow and bear fruits. A single plant may have three, four or even five such gall-like swellings. Very often the affected plant breaks at the point of attack in high wind or on rough handling or heavy bearing. But, as a rule, on the affected plants, even if they bear fruits, the bolls do not openwell.

Plate IV.



Life history and habits.—The whole life cycle of the insect is passed inside the plant. The female weevil thrusts the egg just under the skin of the plant about the ground level. The egg has the same colour as the part of the plant in which the egg is deposited. As many as seven or eight eggs may be found in one stem. The grub hatches out in nine to ten days. The pale whitish grub tunnels into the stem in irregular galleries. When full grown, it is about 5 m.m. in length, stout and curved somewhat like a "po-di-gaung." After about 30 to 40 days it turns into a pupa within the larval galleries. The pupa is naked, not being covered with any hairs or silk. It is pale white, tinged with yellow and is about 4·45 m.m. in length. The pupal skin is cast off on the 9th or 10th day, the insect emerging as an adult weevil. It remains within the burrow for one or two days for the skin to harden and attain its natural colour. The weevil is only a little longer than 3 m.m. and its general colour is dark brown, speckled with white markings. Adult weevils have been known to live for 25 to 30 days in captivity. Thus the length of its life cycle is only about two months.

Other food plants.—Ordinarily, this insect feeds on cotton, but it has been reared on *Hibiscus cannabinus*, *H. esculentus*, *H. Rosa sinensis*, two species of *Abutilon*, *Corchorus olitorius*, and *Ficus religiosa*.

When a field is badly infested, there is no successful way of killing the insect and saving the plants. Being a borer (an internal feeder) it cannot be easily reached or affected by an external application. The indication of the insect attack is visible only when the plant is fairly well bored, and it is impossible to remove the insect without interfering with the growth of the plant. In the circumstances the best thing to do is to uproot the affected plants and burn them with all the insects on them. The insect has been known to attack a cotton plant of only 27 days' growth. It can breed throughout the year. Ratooning provides favourable conditions for the breeding of this insect and is to be avoided.

(9) Thrips are common everywhere on those plants whose growth is slow, but when the growth quickens their presence can be ignored. Their mouth parts are adapted for piercing the living tissues of plants and sucking the sap.

Thrips may occur for years without doing appreciable damage but if the plants are weakened in any way, say, when attacked by another insect, thrips may become serious.

Control.—Spraying with water alone, using some force will suppress the pest. Usually the insect disappears after a heavy shower of rain. Soap solution or rosin compound (described elsewhere in the bulletin) may be used with good results.

(10) *Jassids*, *Empoasca* sp.—This insect belongs to the hopper family. It is of a slender form tapering posteriorly. It rests in a position ready for jumping, which it does on the slightest disturbance. The adult takes to the wing readily, but the nymph is wingless. The female is provided with an ovipositor with which it lacerates the plant tissues for depositing her eggs. The nymph when hatched out feeds on the under side of leaves, causing them to curl up and discolour.

Control.—Weak and unhealthy plants suffer most from this pest. Therefore tillage encouraging healthy growth will control this insect readily. Spraying with soap solution or rosin compound will check the pest considerably as the nymph is vulnerable to these sprays.

(11) *Red mites.*—These are small spider-like creatures living in colonies on both the surfaces of cotton leaves under the protection of their webs. The leaves usually curl over.

Control.—Prompt removal of webbed leaves will keep the pest in check. Healthy, vigorous plants are less likely to be troubled by them and cultural methods to introduce vigorous growth are indicated.

Dusting with flowers of sulphur or spraying with soap solution in which flowers of sulphur is added at one ounce to the gallon of solution are known to check this pest.

(12) *Aphis gossypii*, Glov.—These plant lice ("Pya") are common on a great number of crops, and on cotton it occurs quite often in big colonies on stems, shoots and leaves sucking the sap of food plants.

Life history.—Eggs, dark brown in colour, are laid on the food plant, but the females as a rule produce living young, and not eggs, and these young are usually females which are themselves able to reproduce living young after about three days, no males being produced at all for a considerable number of generations. While the colony is small the members are wingless, but as the colony grows, winged forms are produced which fly off to found new colonies on other plants. Thus they can multiply very rapidly.

Weak and unhealthy plants are their natural hosts. But sometimes when the numbers are great some damage is done to the plants which will then shed tender buds and bolls. This pest however has its own enemies the *Coccinellids*, commonly known as "Lady-bird Beetles" which keep it in check. Roadside plants where a lot of dust is blown on are seldom infested by this pest.

Control.—Cultural methods to increase the vigour of the plants will keep this pest in check.

Dusting with roadside dust will also help. Spraying with soap solution will check this pest effectively.

(13) *Eriophyes* sp.—This mite has been found to retard the growth of cotton plants. It is more prevalent on short-leaf varieties. At first it appears on leaves, particularly the top shoot leaves which become hard, crisp and curly; when occurring on other leaves, such leaves curl over at the sides.

This pest is known to the cultivator in Burma as "byaing-chee" on account of the white patches on leaves giving one the suggestion of a paddy-bird's droppings on them.

Control.—The same measures as suggested for the red mites (No. 11) will hold good here.

(14) *Sylepta derogata* Fb. (Pl. V).—The cotton leaf roller is known to the Burmese cultivator as "ywet-leik-po" due to its habit of cutting the leaf half way and rolling the cut portion into a sort of cone with the open end downwards.

Life history and habits.—Pale yellowish eggs are laid singly by the female moth on leaves and shoots of the food plant usually on the lower surface. The caterpillar that hatches out in two or three days, when full grown is almost an inch long. It is somewhat flattened with very few bristly hairs and of pale greenish colour and semi-transparent. It has a dull yellow head. It feeds within rolled leaves from 13 to 18 days and wriggles about very actively when disturbed. More than one caterpillar may be found in one roll. It then changes into a red brown pupa in the folded leaves. After six to nine days it emerges out as a whitish yellow moth with dark wavy lines across the wings.

Plate V.

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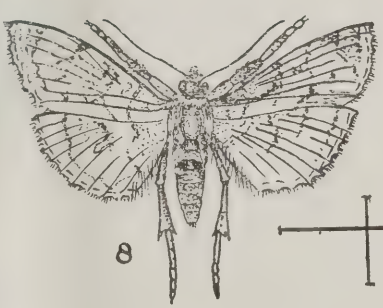

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SYLEPTA DEROGATA.

It is a minor pest, and its main alternative food plant is "yon-pa-di" *Hibiscus esculentus*.

Control.—The folded leaves are easily collected and crushed along with the caterpillars inside.

(15) *Cosmophila indica*, Gn.—This leaf-eating caterpillar is greenish in colour with five white longitudinal lines over the body and is about one inch in length. It feeds on the leaves and pupates within folded leaves.

Food plants.—Cotton, *Hibiscus cannabinus*, *H. Sabdariffa*, *H. esculentus* and other malvaceous plants.

(16) *Phycita infusella*, Meyr. (Pl. VI).—An occasional insect, occurs on top shoots as a minor pest. The pale green caterpillar is only about $\frac{3}{8}$ to $\frac{1}{2}$ an inch in length, stout and smooth except for a few scattered bristly hairs. It has got a dark head. It pupates in folded leaves. The effected top shoots wither and drop.

Food plants.—Cotton *Hibiscus cannabinus* and *H. Sabdariffa*.

Control.—Hand-picking the affected shoots is sufficient.

(17) *Aularches miliaris*, Linn.—A greenish coloured grass-hopper with bright yellow spots over its wings; and the body, ringed alternately with yellow and green, very often the yellow colour is tinged with pink. It is about three inches long and the males are usually slightly shorter than the females.

Life history and habits.—The adults mate during September and October and the female lays eggs in the soil by thrusting its posterior end which extends like a telescope into the soil, perhaps down to three inches in depth. The eggs are in compact masses. The young ones hatch out in about five months time and resemble the parent except in the absence of wings. It takes another five months to become adult and sexually mature to mate and repeat the life cycle. It occurs in swarms by hundreds, sitting on the food plants and feeding on the leaves. It usually occurs from about May to July when cultivated crops bear tender succulent leaves. It is at this time that most damage can be done. Though it occurs from time to time and not in successive years, it has never become a plague. Although it has wings it seldom flies for more than three feet at a time. It is very sluggish in habit and often will not fly even when disturbed.

This pest is reported from Myingyan and the Southern Shan States only.

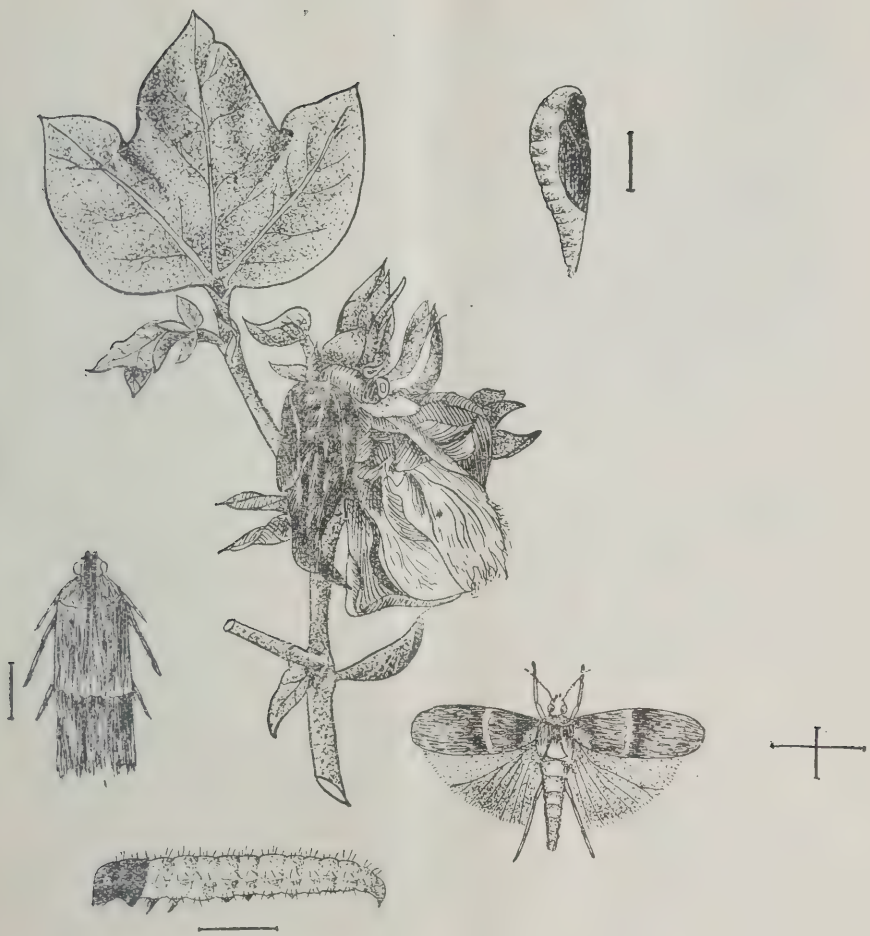
Food plants.—Cotton, pigeon peas, groundnut, sesamum, *Cordia myxa*, "pyaung," *Acacia leucophlœ*, *Melia Azadirachta*, and many wild plants.

Control.—It can easily be collected by tinfuls. Scaring them away with fire brands they will settle on bushes collectively and many may be killed by setting fire to the dry bushes in the months of May to July.

(18) *Diacrisia obliqua*, Wlk. (Pl. VII).—The common hairy caterpillar, known to the Burmese cultivators as "khu", occurs on all the low growing crops in huge numbers. It is polyphagous and due to this habit it is fairly important.

Life history and habits.—The moth, a brownish yellow insect with a few dark spots on the wings, lays eggs in clusters usually on the underside of the leaves of its food plant. Each female is capable of laying up to a thousand eggs. The caterpillars when hatched out, feed gregariously for some time. The attacked leaves become transparent and wither. Later on the caterpillars spread on to neighbouring plants. When full-fed in about three weeks they pupate in rough cocoons made

Plate VI.



COTTON BUD MOTH.

of their hairs with bits of dry leaves incorporated in them. In a little more than a week they emerge out as adult moths. There are five or six broods in a year and thus they can multiply considerably.

Control.—The first attacked leaves and the colony of the newly hatched caterpillars are fairly conspicuous and can be readily gathered and destroyed. Very often, on one leaf alone there will be more than a hundred young caterpillars. The prompt collection and destruction of the first brood puts a check to further breeding of the insect.

(19) *Earias fabia*, Stoll. and *Earias insulana*, Boisd.—The spotted boll-worms of cotton are known as " wathi-po " to the Burmese cultivator. The former is serious.

Earias fabia has been described under the shoot attacking insect above (No. 3). The life history and habits of *E. insulana* is about the same.

(20) *Platyedra gossypiella*, Saund (Pl. VIII).—The pink boll-worm is so called on account of its pinkish colour.

Life history and habits.—The moth, a small dark grey insect, lays eggs singly on the bolls. On hatching out, the caterpillar is whitish in colour and feeds on tender bracts, but later it bores into the boll and feeds on the seeds. It then assumes a pink tinge until, when full grown, it is distinctly pink. It is then about three-fifth of an inch long, moderately stout and smooth except for a few scattered bristly hairs. It has a brown head. It pupates in a slight cocoon on the stem or the boll or in the soil. Near the close of the season the worm may not go into pupation but remain in the seed between harvest and the following growing season, when the adult in due course will emerge and oviposit on growing plants. It can breed several times in a year.

Control.—Prolonged heating of the seeds in the sun has been found to kill many worms that remain dormant in them as the only important source of reinfestation is the seed. Farm hygiene in the form of clearing away all crop-remains by burning after the final picking will destroy the resting insect. The adults are known to be caught in light traps, the males being attracted in a slightly larger number than females, but it was found that the light trap increased infestation in the field rather than reduce it because moths are attracted from surrounding fields.

(21) *Dysdercus cingulatus*, Fb. (Pl. IX).—The red cotton bug is a very conspicuous insect in a cotton field, sitting on stems, flowers and bolls of the food plant. It is quite familiar to the cultivator who attaches little importance to it, though in fact it is a serious pest.

Life history and habits.—The female lays creamy yellow eggs in small masses in the soil. After about a week the young red wingless bugs hatch out and feed gregariously at first. After moulting five times, increasing in size with every moult, they become winged adults in from five to six weeks. The bug draws in its food through its rostrum which it thrusts into the plant tissues, the adult piercing the bolls and sucking the seeds. The internal boll-rot of cotton is associated with this pest. As a rule the attached boll does not open, and if it does, no lint is produced. Very often the lint of the open ripe bolls is stained yellow by this bug.

Control.—Feeding gregariously in the nymphal stage, large numbers can be collected into a pan of water. A thin film of kerosine over the water will prevent the bugs from crawling over and escaping. Holding

Plate VII.

Diacrisia obliqua, Wlk.

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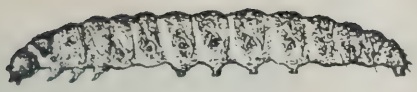
Plate VIII.



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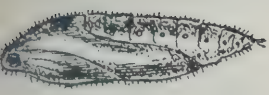

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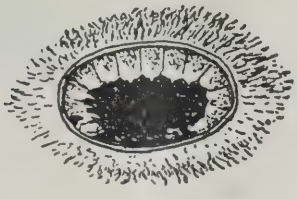

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Platyedra gossypiella, Saund.

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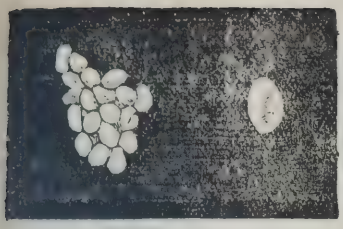
Plate IX.



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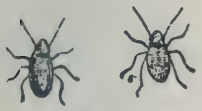

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DYSDERCUS CINGULATUS

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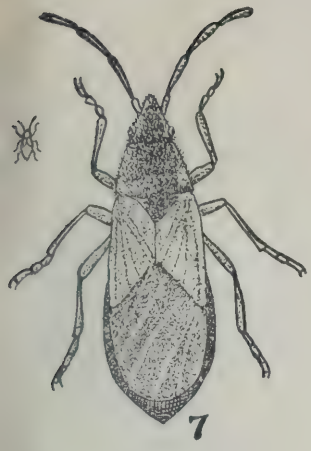
Plate X.



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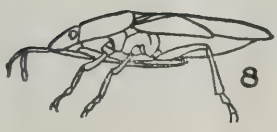

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6

OXYCARENUS LÆTUS.

the pan under the colony and sharp tapping of the part of the plant, the colony is resting on, will readily dislodge them. The adults will however fly off on disturbance.

(22) *Oxycarenus lætus*, Kby. (Pl. X.)—The dusky cotton bug is a small black insect found on old open bolls and bolls damaged by boll-worms.

Life history and habits.—The female lays eggs in small groups in the lint of ripe bolls or between the calyx and the boll. The egg is cigar-shaped, grooved longitudinally, and white in the beginning, turning pale yellow and then orange just before the wingless nymphs emerge. After six moults, they attain the winged adult stage.

Control.—The damage computed to this insect is very little. It attacks mainly bolls already damaged by the boll-worm. Seeds of open bolls may be fed upon and the germination or the oil content of such seeds are affected. Old picked bolls and unopened bolls should be removed along with this insect on them and destroyed periodically.

Conclusion.

Of the various modern methods of control of crop pests such as chemical, biological, cultural and legislative, the Burmese cultivator has within his means and comprehension only the cultural methods of control. By regulating his farm practice in accordance with the following suggestions, insect pests may be kept at a disadvantage :—

(1) Selection of sound seeds in order to have healthy vigorous plants able to withstand the attack of insects to a considerable extent, as well as eliminating hibernating insects from the seeds.

(2) Varying the time of sowing in order that the vulnerable, vegetative period does not coincide with the maximum number of insect pests.

(3) Rotation of crop by means of which the farmer avoids providing the same food plant for the pest continuously.

(4) By cultivating the soil thoroughly, the pest is affected in two ways ; indirectly by producing a medium for rapid and vigorous growth of the crop, and directly by disturbing the insects in their habitat and exposing them to their natural enemies.

(5) Manuring at the right time stimulates plant growth and helps the crops to withstand or recover quickly from insect attack.

(6) Farm hygiene is important. Clean cultivation does away with wild host plants on which many pests of crops remain during off seasons until the favoured crop comes round again. Under this will be included the removal and burning of crop remains and rubbish.

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BULLETIN No. 12 of 1914

THE PEAS AND BEANS OF BURMA

BY

E. THOMPSTONE, B.Sc.
DEPUTY DIRECTOR OF AGRICULTURE, BURMA

AND

A. M. SAWYER,
ASSISTANT AGRICULTURAL BOTANIST, BURMA

RANGOON
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, BURMA
1914

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Department of Agriculture, Burma

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THE PEAS AND BEANS OF BURMA.

Introduction.

The study of this subject was commenced, at the instance of the Director of Agriculture, Burma, in the year 1908. It was then intended that a short survey of the Peas and Beans of Burma should be conducted; but, as the work progressed, the subject presented such a variety of difficult features that we found justice could not be done it unless a much more complete enquiry than was at first proposed were carried out. The present book is therefore the result of almost four years' work, during which several hundred samples of beans were examined and a very large number cultivated at Mandalay and studied throughout their growth for three seasons. Many, which could not be grown here, were examined in the localities where they were found.

In so far as they are at present known to us, the cultivated Papilionaceous plants of Burma form an interesting collection of valuable species included in the genera mentioned in the Botanical Index. The genus Arachis has been omitted from this book. The importance of the Groundnut in the Dry Zone of Burma, whose precarious agriculture its advent has considerably changed, is such as to lead us to believe that it merits ampler treatment than can be given it here. Accordingly we have relegated its study to a not distant future in which we hope to give it the special attention it deserves.

Although the cultivated Papilionaceous plants of Burma, which we have called its "Peas and Beans," are by no means peculiar to this region, it is interesting to note that they include the majority of the world's cultivated food-plants belonging to this Sub-order. Nevertheless, at the present time, but a few of the species studied are cultivated as field-crops; for, as yet, the greater number of the Burmese peas and beans are grown only as garden-plants. The more important field-crops are furnished by the commoner species and varieties of Phaseolus and Vigna, a feature presented in common with India. But, whereas in India, the commoner "pulses" are the products chiefly of Phaseolus Mungo, in Burma it is Phaseolus lunatus which is the more usually favoured for field-cultivation. Some of the varieties of Dolichos Lablab are also valued Burmese field-crops, though by far the larger number are grown as garden-plants and, along with some of the Vignas, furnish the chief esculent beans of the people. By esculent beans we mean those that are eaten in the green state and partly cooked after the manner of the European Kidney bean. Pisum and Glycine, which are almost always field-crops, are grown as yet to a limited extent, but Pachyrhizus and Psophocarpus, which are elsewhere usually garden crops, are among the smaller but most cherished field products in this country. The cultivation of Cajanus, as a field-crop, is as yet slight but is extending with the expansion of the Indian population.

Among the more important reasons which have induced us to take up the study of the peas and beans of the Province and embody its results in the shape of a book is the circumstance that there is as yet

no work of the kind to serve for a guide to District officers, merchants students and others whose duties or interest might lead them to dea with this valuable and interesting group of plants. Indeed, we are inclined to the belief and entertain the hope, that, with the aid of this treatise, mistakes like that which includes the beans of two such widely different genera as Dolichos and Phaseolus under the one name o "White Beans" in some important Government and Commercia publications will not recur in the future. There is a vague notion in the lay mind that two white beans, because they are white, must per force be one and the same. We hope that a study of the book wil emphasise the fact that colour is one of the least reliable of the characters that can be taken as a guide in the study of the identity o plants. Moreover, the current Burmese local names are not of any great value in identification, especially of this group of plants; for whilst sometimes consistent and furnishing a fairly correct clue, they are very frequently vague and inconsistent and, therefore, apt to be misleading. Not only are different names given, even in the same locality, for the same plant but entirely different plants are known by the same name. Nothing can conduce to greater confusion. We hope that the book will be of some use in the elucidation of the mysteries o this mixed nomenclature.

The importance of the food-value of beans in the dietary of a people which lives chiefly on rice is another and potent argument which has prevailed with us in inviting special attention to them. They are at present almost the only vegetable source of nitrogenous food which is available to the Burman; and we hope that the publication of the book will tend to give a wholesome impetus to the more systematic and extended cultivation of so valuable a food-stuff. It may also possibly tend to excite the flow of native and foreign capital in the direction of the cultivation of these important plants on a large and profitable commercial scale; for, it is our conviction that many of the Burmese peas and beans have a distinct economic future before them and but await the expenditure of money and enterprise to become productive sources of much wealth to the country. To those inclined to doubt the soundness of the foundations for this belief we would indicate the remarkable strides that have been made and the position now occupied by the groundnut in the districts within the Dry Zone o Burma, where, almost unknown but a few years ago, it now already covers more than 100,000 acres. Again, the demand, at renumerative rates, for such of the Burmese beans as are already known to the commercial world is increasing and is greater than the supply. There is plenty of land, at present waste, suitable for the cultivation of these crops and but population and a little capital are required to make i thoroughly productive.

As regards the book itself, though it does not profess to be complete or final, the nature of the subject being such that it cannot be, i is intended as a Botanical and Agricultural guide to the identification classification and study of the Burmese cultivated pulses as they are a present known to us, and aims at giving concisely the more important characters and the utility of the plants described. As this is not a treatise on Systematic Botany, we have not included many of the numerous synonyms which belong to a large number of the species, but

have only found space for those which are most familiar. The student of synonymy is referred to the more extensive works on Systematic Botany, such as Hooker's "Flora of British India". A salient feature of the book are the keys to the genera, species and varieties dealt with. These will be found to be of special use to the general student. In their preparation, as in that of the book itself, the "Flora of British India" and Professor Gammie's "Field, Garden and Orchard Crops of the Bombay Presidency" have been freely consulted and drawn upon. But for any deviations from the descriptions of such of the plants as appear in the above works we are responsible. Following the keys are botanical descriptions of the species, varieties and races treated of. Each botanical description is itself succeeded by a tabular statement giving the distribution of the plants described. By the term distribution we, however, mean merely the places from which, for our study, the plants or their seeds were collected or obtained. Such a distribution can by no means be full or even definite as regards the localities of cultivation; but we believe that the distribution lists are at the same time fairly complete statements of the places in which the plants are to be found. Notes giving the agricultural treatment, economic uses and value of the plants conclude the information given under each. Though concise, these notes are the summary of our present knowledge and are the result of much study and research. They reveal some interesting methods of culture and some utilisations believed to be peculiar to Burma.

As defined in the Glossary, the term "Race" is applied in its loose and more indefinite agricultural sense and not in its strictly botanical one. Some of our "races" may include forms that show enough variation, under certain conditions, to consign them to the position of only sub-races or, on the other hand, such a constancy of characters as to be regarded in the light of varieties. To study the range of variation and fixation of characters in races is a matter of much time and a great deal of observation. Even sub-varieties sometimes appear to merge into one another. The intermediate forms, the presence of which lent special difficulty to the task of classification, are in many cases believed to be the result of casual hybridisation. In the plan of classification adopted in the book, we have, as is usually done, taken the more persistent characters as varietal and sub-varietal and the less persistent or unimportant ones to serve in the discrimination of the races. Colour alone, one of the most variable attributes, has been employed in the somewhat slight distinctions which we have drawn between races and their sub-divisions.

Fifty-six hand-coloured Plates to illustrate the text have been made by Mr. Sawyer and a complete set of drawings to aid the botanical descriptions of the plants have been made by Artist-Fieldman Whay Ta Yin. Owing, however, to the prohibitive cost of publication these will not be published for the present but remain as a work of reference in the office of the Deputy Director of Agriculture, Mandalay, and will be at the disposal of those who may wish to consult them.

A full Glossary, for the benefit of non-botanists, is appended an Indices added to the book.

While mentioning the fact that most of the samples of seed selected for study were collected by Deputy Director of Agriculture, Northern Circle, we beg to express our acknowledgments to the Deputy Director of Agriculture, Southern Circle, and to the various Deputy Commissioners and other District officers and officials who have helped us in our study with samples of seeds; while, to Mr. Mackenna, our Director, we would express our gratefulness for his ever-ready sympathy and cheerful encouragement throughout the long period of very heavy work which the study for this book has entailed upon us.

MANDALAY, *March* 1914.

A Key to the Genera described in this Book.

Tribe Genisteae.—*Stamens monadelphous, leaves simple or digitate*:—

Anthers dimorphous, keel beaked, pod turgid ... *Crotalaria.*

Tribe Galegeae.—*Stamens usually diadelphous, leaves usually imparipinnate*:—

Anthers apiculate, stamens monadelphous, leaves imparipinnate, hairs fixed by the centre ... *Cyamopsis.*

Anthers obtuse, stamens diadelphous, leaves abruptly pinnate, hairs fixed by the base ... ... *Sesbania.*

Tribe Vicieae.—*Stamens diadelphous, leaves abruptly pinnate, petiole ending in a tendril or bristle*:—

Anthers uniform—

Leaflets serrate ... ... *Cicer.*

Leaflets entire—

Tube of stamens oblique at mouth—

Plant glabrous, seldom branched, stout-stemmed; pod large, sub-cylindrical, velvety when young, 2 to 5 seeded ... ... *Vicia.*

Plant softly-hairy, much branched, slender; pod short, compressed, dry, smooth, 1 to 2 seeded ... ... *Lens.*

Tube of stamens truncate at mouth—

Style spatulate at apex ... ... *Lathyrus.*

Style falcate, laterally compressed ... *Pisum.*

Tribe Phaseoleae.—*Stamens mon—or diadelphous, leaves pinnately trifoliolate*:—

Leaves not gland-dotted—

Style beardless—

Anthers uniform, petals equal or sub-equal, stamens monadelphous—

Tube of calyx campanulate, 5 toothed, pod generally small, pubescent ... ... *Glycine.*

Tube of calyx gibbous, 2 lipped, pod large, glabrous and ribbed on each valve along the upper suture ... ... *Canavalia.*

Anthers dimorphous, petals unequal, stamens diadelphous—

Tube of calyx campanulate ... ... *Mucuna.*

Style bearded—

Anthers uniform, petals equal or sub-equal, stamens diadelphous—

Stigma oblique—

Keel spiral ... ... *Phaseolus.*

Keel obtuse—

Style filiform, straight ... ... *Vigna.*

Style flattened, circinnate ... *Pachyrhizus.*

Stigma terminal—

Keel obtuse or rostrate; pod flattened, recurved ... ... *Dolichos.*

Keel not rostrate; pod square, 4 winged .. *Psophocarpus.*

Leaves gland-dotted—

Style beardless—

Anthers uniform, petals equal, stamens diadelphous—

Stigma capitate—

Keel truncate; pod compressed, lineate ... *Cajanus.*

Crotalaria juncea, Linn; Sann or Sunn Hemp.

A stiff, erect, annual shrub up to 8′ in height, with slender, virgate stems and branches which are terete, sulcate, and silvery-sheened from the presence of soft, silky white hairs.

Leaves 2″ to 4″ long, distant, simple, oblong-acute, entire, short-petioled, with silky white hairs, especially on the lower surface; *Stipules*, when present, minute and subulate.

Flowers large and conspicuous, bracteate and pedicellate on the long and lax axillary or terminal racemes; *calyx* somewhat exserted; *standard* reflexed, short-clawed, ovate-acute, from one-and-a-half to twice the length of the wings, bright yellow faintly streaked with purple on the dorsal side where it is also covered with fine white hairs; at the base it is thrown into two incurved folds or calli which are purple and conspicuous on the ventral side; *wings* narrow, blunt, oblong-oblique, deep yellow with a purple streak at the base; *keel-petals* united to near the base, ovate, incurved, saccate, rostrate, longer than the wings but shorter than the standard; *stamens* monadelphous; *filaments* unequal; *anthers* dimorphous,—5 being small ovate, and dorsifixed on long filaments, alternating with 5 long, lanceolate anthers basifixed upon the apices of short filaments; *ovary* short, broad, sessile, recurved, narrowing into the long and slender erect style which is abruptly incurved and narrowed at the base, but broad and flattened at the distal end; the *style* is hairy over the greater part of its length, bearded on its upper ventral edge, and is penicillate around the stigma which is minute and very oblique.

Pod about 1″ to 1·5″ long, more or less cylindrical, turgid, and velvety from the presence of a dense covering of short white hairs; indehiscent.

Seeds 10 to 15 per pod, reniform, with a prominent hooked beak, olive-brown in colour.

Size of seed:—

L. 0·25″—0·3″
B. 0·15″—0·2″
T. 0·1″ ...

Weight per 100=4·05 gms., or 700 seeds per oz.

Distribution.

Under the name of *Pike-san-bin*, *Crotalaria juncea* is cultivated in most districts in Burma. It is usually grown on garden land, but sometimes as a field-crop to a limited extent. In Lower Burma it is grown chiefly on the banks of "*Chaungs*" or creeks; in Upper Burma it is grown along the riverain areas and sometimes in other places where light soil is found. Very little care is bestowed on the cultivation. The ground is roughly harrowed with the "*htūn*" and the seed is sown broadcast at the rate of about 60 lbs. per acre. No weeding is carried out and the crop is usually allowed to ripen before being cut.

(Note.—Keys to Species, Varieties, etc., are given under the Genera.)

The hemp ("Pike-san-shaw") is prepared by retting the stems in water for a week or ten days and washing and sun-drying the fibre; it is used chiefly for making fishing-nets but also for ropes. The young and tender leaves and flowers are eaten, being cooked in various ways, but chiefly in the preparation of "*heincho*" (soup).

Crotalaria retusa, Linn.

This is the Burmese *Taw-pike-san*. It grows to a height of 4′ to 6′, has stout, striated branches, very minute stipules, obtuse and cuneate, glabrous leaves, small flowers which are distantly set on long racemes, and linear-oblong pods bearing numerous jet black seeds.

This plant is of little importance but it is sometimes grown in gardens for its leaves and flowers which are used like those of the *Pike-san-bin*.

The fibre, however, is seldom extracted.

Cyamopsis psoralioides, DC. Cluster bean.

An erect annual, 2′ to 6′ in height, with 4-to-5-angled, grooved, flexuose stems and branches, and all parts scabrid from the presence of white hairs which are attached by the middle.

Leaves trifoliolate; *leaflets* 2″ to 4″ long, ovate or elliptical, dentate or distantly serrate, acute; *laterals* seldom and but slightly oblique; *stipules* linear, setaceous; *stipels* hairy, inconspicuous.

Flowers small (about 0·25″ long), white or slightly tinged with purple, borne singly in the axils of linear bracts and crowded on short axillary racemes; *calyx-tube* oblique; *teeth* setaceous, lanceolate, unequal (the anterior the longest); *corolla* slightly longer than the anterior tooth; *petals* equal, caducous; *standard* erect, oval, sub-emarginate; *wings* obovate, oblique; *keel* obtuse and incurved; *stamens* monadelphous; *anthers* uniform, ovate, apiculate; *ovary* oblong, sessile; *style* short, curved inwards; *stigma* terminal and capitate.

Pods linear-oblong, erect or sub-erect, straight or slightly arched outwards, sessile or sub-sessile, rostrate, usually even over the thickened sutures but slightly constricted laterally between the seeds; septate, indehiscent, valves thick and fleshy in the young pod but stiff and brittle in the dry.

Seeds three to ten per pod, small, flattened, irregularly rounded, retuse or sub-retuse; *testa* hard, horny, granulated; colour grey to black; *hilum* small.

Size of seed:—

L. 0·15″—0·2″
W. 0·15″—0·2″
T. 0·1″ nearly.

Weight per 100=6·26 gms., or 452 seeds per oz.

Notes.

The young pods of *Cyamopsis psoralioides*, usually known in Burmese as *Pè-walee* or *Walee-pè*, are cooked and eaten as a vegetable. For this purpose, the plant is now cultivated, to a small extent, in "market-gardens", near the larger towns of Burma, and not as a field-crop, so far as we know. It is cultivated on rich soil in the same way as any other vegetable, being sown during the rains and is ready for consumption from October onwards. As a food stuff it is not so much in favour with the Burman as with the native of India, though the former also consumes it.

In his "Review of Information on the Burmese Peas and Beans," page 11, the Reporter on Economic Products, India, says that he found the pods being sold in Moulmein under the name of *Pè-nan-tha* (lit: the pea with an odour)—a name which, in Burma, is usually applied to Fenugreek (*Trigonella Foenum graecum, Linn*). In the same Review the Reporter on Economic Products says that "in 1903 south of Kyaukse, I found a great deal of it in a plantain garden where it is apparently used for packing the fruits." On close examination, however, we find that the plant which is generally used for this purpose is

not *Cyamopsis psoralioides* but a wild plant (a species of Psoralea) with a disagreeable odour, very similar in appearance to and easily mistaken for the Cluster bean. This wild plant which is very abundant in the gardens and on the *Kazins* of paddy fields in many districts is used for wrapping up green bunches of plantains, either before or after cutting. The heat developed from the green plant, whilst decaying, induces the plantains to ripen quickly and uniformly.

Sesbania grandiflora, Pers.

A deciduous tree 10′ to 30′ in height, with slender terete branches on which the leaves are crowded towards the ends.

Leaves, from 6″ to 12″ long, abruptly pinnate; *leaflets* about 1″ in length, oblong, blunt, glabrous, pale green, opposite or sub-opposite in from 10 to 20 pairs on the stout and terete common petioles; *petiolules* short; *stipules* large, ovate-oblique, acute, basifixed; *stiples* minute, lanceolate.

Inflorescence a lax axillary raceme; *flowers* large 2 to 4, usually 3; *pedicels* long, falcately curved, with two minute bracteoles near the middle; *calyx* about 1″ long and ½″ broad, campanulate, two lipped; *bud* falcately curved; *corolla* much exserted, 3″ to 4″ long; *petals* equal, long-clawed, white; *standard* reflexed, ovate-emarginate, pure white with a pale green base; *wings* ovate-lanceolate, oblique; *keel-petals* united for the greater part of their length, similar to the wings in shape but broader, more incurved and somewhat rostrate; *stamens* diadelphous; *tube* arched inwards, narrowing from a saccate base; *anthers* uniform, lanceolate, dorsifixed; *ovary* stipitate, linear, many-ovuled, narrowing into the somewhat short style; *stigma* capitate.

Pod from 10″ to 20″ long, about ⅝″ broad, and ¼″ thick, straight or more or less falcately curved, long-stalked, straight-beaked, sub-tetragonous from the thickening of the sutures, dehiscent, septate.

Seeds small, numerous (often more than 40 per pod), reniform, brown in colour.

Distribution.

This species, under the name of *Pauk-pán-byu*, is cultivated in most districts of Burma, chiefly in gardens as supports for betel-vines. The young leaves, shoots and pods are par-boiled or scalded and eaten with "*ngapi*"; the older leaves are boiled into soup ("*heincho*"); and the flowers are made into salad.

Sesbania grandiflora, var: coccinea.

(Syn. Aeschynomene coccinea, Linn).

This variety which is cultivated in the same manner and for the same purposes as the Sesbania grandiflora, is the "*Pauk-pán-ni*" of the Burmese. It is a smaller tree (up to 20 feet) than S. grandiflora, and has crimson flowers which are usually germinate.

Sesbania aculeata, Pers, the Indian "*daincha*," has recently been introduced as a green-manure crop.

Cicer arietinum, Linn.

Gram or Chick-pea.

Annual herbs with short, much branched, erect stems; all parts clothed with viscous hairs ; height 6″ to 18″.

Leaves usually imparipinnate ; *leaflets* opposite to alternate, ovate to elliptical or oblong, sharply serrate, acute, almost sessile, about 13 to 15 per leaf ; *stipules* small, oblique, deeply toothed.

Peduncles bearing single flowers, solitary in the axils of the leaves ; *calyx-tube* oblique, five-toothed, teeth lanceolate, sub-equal ; *corolla* exserted, very slightly longer than the calyx ; *standard* broad, exceeding the wings and keel, purple ; *wings* obliquely obovate ; *keel* incurved ; *stamens* 10, diadelphous ; *anthers* uniform ; *ovary* sessile, usually two-ovuled ; *style* incurved, beardless ; *stigma* terminal, capitate.

Pod oblong, turgid, pubescent, with persistent style, usually two-seeded ; length 0·75″, breadth 0·35″.

Seeds ovoid, compressed, beaked, of uneven surface, but uniformly crinkled and very characteristic shape.

Size of seed :—

L. 0·3″—0·35″
B. 0·2 ′—0·25″
T. 0·2″—0·25″

Weight per 100=11·6 gms., or 244 seeds per oz.

The variety of Gram grown in Burma may be divided into two races the seeds of which are often found mixed together.

Race (*i*) :—

Seeds—dark brown.

Distribution.

Locality.	Local name.	Remarks.
Bassein ...	Kala-pè ...	This race is frequently known as " Leik-thè " Kala-pè.
Ma-ubin ...		
Pegu ...		
Toungoo ...		
Sandoway ...		
Meiktila ...		
Yamêthin ...		
Henzada ...		
Mandalay ...		
Shwebo ...		
Kyauksè ...		
Myingyan ...	Kala-pè ...	This name " Sin-gaung-kala-pè " seems to be used also in Lower Burma to denote gram generally.
	Sin-gaung-kala-pè	
Sagaing ...	Kala-pè ...	Mixed.
Lower Chindwin ...		
Upper Chindwin ...		
Sandoway ...	Myin-sa-pè.	
Akyab ...		

Race (*ii*) :—

Seeds—pale yellow.

Distribution.

Locality.	Local name.	Remarks.
Mandalay ...	Kala-pè ...	This race is frequently known as "Shwè-wa" Kala-pè.
Prome ...		
Tharrawaddy ...	Kala-pè ...	Mixed.
Hanthwaddy ...		
Kamaing (Bhamo) ...		
Magwè ...		
Pakôkku ...		
Minbu ...		
Thayetmyo ...		

Notes.

Gram is entirely a cold weather crop, the seed being scattered about October or November. For gram-cultivation the stiffer and black soils are preferred, but it is also sown on light soils in many places. It is grown to a considerable extent on islands, inundated river-lands and on paddy-lands which have not received sufficient rain water to enable a crop of paddy to be grown during the rainy season. It is frequently also scattered among "Kauk-gyi" paddy, while the ground is still wet, about November. After the paddy is reaped it continues to thrive and produces a crop during the cold weather. It is sometimes also sown mixed with wheat in the wheat-growing areas of Sagaing. The seed is ordinarily sown broadcast at the rate of about half a basket per acre and sometimes, when the plants are a few inches high, they are thinned out by the "*htūn*" (Burmese harrow). They are also "pruned" by pinching off the tips which are made use of as a vegetable. Reaping takes place about February or March, the plants being pulled up by the roots. Threshing is done in the ordinary way by treading with bullocks. An average outturn will be about 15 baskets per acre. The produce is largely consumed by natives of India, but also, to some extent, by the Burman population. It is sold in the bazaars in various forms as split *dál*, parched, boiled, fried, or as meal. A considerable portion of the crop is disposed of to the Commissariat and Police departments and a good deal is also used for feeding ponies. There is little, if any, available for export, the supply being unequal to the demand. The tips of the young plants or branches are a favourite curry stuff with both natives and Burmans. The cultivation of this crop is extending rapidly, and the distribution becoming general throughout Burma.

Besides the two races described above, several new races have lately been introduced but they are not yet in the hands of the cultivator.

Vicia Faba, Linn.

(Syn. *Faba Vulgaris*, Moench.)

Annuals, from 2″ to 4″ in height, with grooved, subtetragonous, flexuose, stout, unbranched, hollow stems ; all parts glabrous.

Leaves pinnate with 3 to 7 leaflets of which the laterals are sub-opposite or alternate ; *leaflets* entire, ovate-elliptical, mucronate, smooth, thick ; *stipules* ovate to lanceolate, semisagittate, sometimes toothed ; *stipels* inconspicuous ; *tendril* reduced to a bristle—or sometimes wanting.

Flowers in two-to six-flowered short racemes borne in the axils of the leaves all along the stem : *calyx* campanulate oblique, teeth triangular ; *standard* sub-erect, longer than the wings, spatulate, white, faintly streaked with black on the dorsal side ; *wings* short with long spurs, white with a black patch in the centre ; *keel* oblique, crumpled, white ; *stamens* short, diadelphous ; *stigma* two-cleft, hairy.

Pods large, sub-cylindrical, or flattened, strongly rostrate, succulent, velvety when young, with a thick spongy lining, hard, tough and black when ripe.

Seeds 2 to 5 per pod.

There are two distinct varieties of this bean :—

Variety (1) :—

Pods large, broad (3″ to 4½″ long and ¾″ to 1″ broad) and somewhat flattened ; generally with 2 or 3 seeds ;

Seeds large oval to sub-retuse, much flattened, greenish to dark brown.

Size of seed :—

L. 0·6″—0·9″
B. 0·5″—0·65″
T. 0·1″—0·2″

Weight per 100=118·15 gms., or 24 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Bhamo	Tayôk-pè.	
Kamang (Bhamo) ...	San-to-pè.	
Kachin Hills ...	San-du-si.	
S. Hsenwi State (N. S. S.)	Pè-let-ma.	

Notes.

San-to-pè is said to be the Chinese name for the bean, and it is believed by the Burmans to have come over from China. We think there is little doubt that it has been introduced within recent years. It is similar in all respects to the European broad or long-pod

bean except that the fruits and seeds are somewhat smaller. It is cultivated only to a moderate extent, both as a field and a garden crop, on the light soils of the Bhamo District. It is said, however, that it will grow on any soil, and the cultivation is extending. On the plains round Bhamo it is sown broadcast about October and the seed is harrowed into the soil. The pods are plucked from January onwards. In the Hills it is often sown during the rains and gathered from November onwards. The seeds are consumed by all classes of the local population both green and in the matured state. Excellent samples have been exhibited at the Bhamo Agricultural Show and, were the demand to arise, we have little doubt that they would rapidly become available for export. Though the "haulms" (stems and leaves) make good fodder, they are not yet used by the cultivators for this purpose.

Variety (2) :—

Pods smaller than *Var*: 1 (length 3″ to 3½″, breadth ½″ to ¾″) much more tumid, with 3 to 4 seeds ;

Seeds smaller than *Var* : 1, short, plump, with rounded ends.

Size of seed :—

L. 0·5″

B. 0·35″—0·4″

T. 0·2″—0·3″

Weight per 100=64·5 gms., or about 44 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Maymyo and S. Hsenwi State (N. S. S.)	Bo-sá-pè.	

Notes.

This variety is very similar to the English Horse or tick-bean. There is little doubt that this also is an introduced variety. It is cultivated, so far as we know, only as a vegetable. Its cultivation is similar to that of *Variety* 1, though more care is usually taken in the sowing. The fruits are brought down from the Northern Shan States to Mandalay throughout the cold weather and sold in the bazaars. Of this variety, the entire green fruit is frequently consumed, though the seeds are more esteemed. It grows readily and might be extended to field cultivation. The samples of beans obtained by us were of very good quality.

Lens esculenta, Moench. Lentil.

(Syn. *Ervum Lens*, Linn.)

Erect, much-branched, softly-hairy, annual plant with slender stem and branches.

Leaves pinnate, ending in a tendril, leaflet or bristle ; *leaflets* seldom more than two pairs, sessile, lanceolate, entire ; *stipules* semi-sagittate ; *stipels* absent.

Flowers solitary, or in racemes of seldom more than two, on axillary peduncles ; *bracts* and *bracteoles* usually absent ; *calyx-tube* oblique, lobes 5, elongate, almost equal in length to one another and twice as long as the tube ; *corolla* slightly exserted, white to pale purple ; *standard* broad ; *wings* oblong-oblique ; *stamens* 10, diadelphous ; *mouth of tube* oblique ; *anthers* uniform ; *ovary* nearly sessile, two-ovuled ; *style* inflexed, bearded on the inner curve.

Pods oblong, rhomboid, compressed, smooth, short (about 0·5 inch long), non-septate, one-to two-seeded.

Seeds small, round, compressed, bi-convex, grey to light-red in colour speckled with black.

Size of seed :—

L. 0·12″—0·15″
B. 0·12″—0·15″
T. 0·05′—0·1″

Weight per 100=1·9 gms., or 1,492 seeds per oz.

Distribution.

Locality.	Local name.	Remarks
Mandalay, Amarapura, Sagaing.	Pè-yáza ...	Lit. " Royal pea. "
Pakôkku	Pè-sán-bán.	

Notes.

Although this pea was received only from four localities, it is very widely distributed and is found growing wild in most districts in Burma. It is, however, very seldom cultivated and then very little care is bestowed on the cultivation. The situations usually selected for its cultivation are on islands and in riverain areas. The seed is scattered about October or November and the crop is reaped about March.

There are probably two races—one with a light-red seed speckled with black and the other with a grey seed speckled with black; but we have been unable, up to the present, to verify this statement. The seed from Pakôkku was mostly of the red kind while that from Amarapura was mostly of the grey kind.

Lens is of very little importance as a crop in Burma. Most of the seed sold in the bazaars appears to be imported from India and is eaten chiefly by natives of India. The name Pè-yàza means "Royal Pea" and it has been suggested by the Deputy Director of Agriculture, Southern Circle, that its cultivation was probably introduced by Indians living near some of the old capitals. There is a good market for the produce and it would seem that the cultivation of this pea might be profitably extended.

Lathyrus sativus, Linn.

A procumbent, slender, much-branched, herbaceous annual with winged stems, branches, and petioles; all parts glabrous.

Leaves pinnate, ending in 1 to 3 delicate tendrils; *petioles* winged; *leaflets* 2 to 4, entire, linear-lanceolate, sessile (leaves with only two leaflets generally bear 3 tendrils; whilst those with 4 leaflets have but one tendril; frequently a third perfect leaflet is opposed by a tendril); *stipules* ovate, entire, attached below the middle (about one-fourth above the base); *stipels* minute or absent.

Peduncle simple, single-flowered; *flowers* conspicuous, blue or purple fading to red; *calyx-tube* campanulate, deep-lobed, lobes lanceolate, sub-equal; *standard* oblate, emarginate, reflexed, deep blue with crimson centre; *wings* beaked in at the apex; *keel* shorter than wings; *stamens* diadelphous, *tube* truncate; *anthers* uniform; *ovary* broad, stalked; *style* flattened, obscurely hairy on inner curve, *stigma* spatulate, hairy on edges.

Pods oblong, retuse, rostrate, with a narrow wing on each side of the ventral suture.

Seeds 3 to 5, more or less wedge-shaped, with the dorsal surface forming the thin edge of the wedge, ends retuse; colour grey, speckled with brown or black.

Size of seed:—

L. 0·15″—0·2″
B. 0·15″—0·2″
T. 0·15″—0·2″

Weight per 100=5·8 gms, or 488 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Amarapura	Pè-kyin-boung.	
Ava		
Mandalay		
Madaya		
Pakôkku		
Mandalay	Pè-sa-li.	

Notes.

This plant is cultivated only to a small extent in Burma, though it is frequently found growing wild with other crops, *e.g.* peas, when it is collected and eaten by the cultivator. It grows during the cold season, being sown broadcast on islands and inundated light lands. Where sown, it is generally mixed with the seeds of some other crop. It is reaped in February—March, and yields 7 or 8 baskets per acre. The seeds are consumed after being boiled or parched; but if eaten in large quantities it is said to produce a sort of paralysis known as "lathyrism": (Bur. lè-thin-dôn).

Pisum.

Diffuse, climbing, tall or short, annual plants, with all parts glabrous and usually glaucous.

Stems weak, cylindrical.

Leaves pinnate, with the cylindrical petioles terminating in tendrils; *leaflets* 2 to 6, usually opposite, ovate, entire, undulate, thick; *stipules* large, leafy, persistent, sub-cordate or auriculate, toothed at the base; *stipels* absent.

Peduncles axillary; *flowers* conspicuous, solitary or racemose (racemes 2 to 3 flowered), white, pink, or purple in colour; *bracts* very small; *bracteoles* absent; *calyx-tube* oblique; *calyx-lobes* unequal (usually sub-equal); *standard* obovate, or almost orbicular; *wings* falcately-oblong, longer than the keel; *keel* short, incurved, obtuse; *stamens* diadelphous; *staminal tube* truncate, grooved; *filaments* broad, spatulate; *anthers* uniform; *ovary* oblong, short-stalked, many-ovuled; *style* sickle-shaped, flattened, bearded on inner curve; *stigma* minute, terminal.

Pods tumid or compressed, usually straight, rounded at the distal end, obliquely-acute; *valves* parchment-like, continuous within, curling but slightly on the dehiscence of the pod.

Seeds 4 to 8, spherical and tumid or sometimes slightly compressed, smooth or wrinkled, yellow or greyish-green, brown, black, marbled, or speckled.

There are two distinct species of Pisum described below but, up to the present, we have been unable to separate any varieties or races under either of them.

Species A.

Pisum arvense, Linn.,—The Grey or Field Pea.

Plants dwarfish, hardy.

Leaflets 2 to 4.

Flowers pink to purple.

Seeds small, round, somewhat compressed, grey, grey-green, or dun coloured, marbled or speckled with purplish-brown.

Size of seed:—

L. 0·25″
B. 0·25″
T. 0·2″

Weight per 100=16·5 gms., or 172 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mungloi (Kachin Hills)	San-too-see. Wan-du-si.	
Mômeik (Katha) ...	Pè-si-lôn ...	Mixed with Sadaw-pè Mômeik, Sp. B., P. Sativum.
Lashio (Northern Shan States).	Sadaw-pè or To-kan	Mixed with Pisum sativum, Sp. B.
Hsipaw (Northern Shan States).		

Locality.	Local name.	Remarks.
Bhamo	Sadaw-pè ...	Mixed with Pisum sativum, Sp. B.
Myingyan	Do. ...	Do. Do.
Amarapura	Pè-si-lôn.	
Madaya	Sadaw-pè.	
Mohnyin	Do.	

Species B.

Pisum sativum, Linn.

Plants usually tall, delicate, hollow-stemmed.

Leaflets 4 to 6 in number.

Flowers white, usually in pairs.

Seeds spherical, smooth, of a uniformly cream-white or pale yellowish-green colour.

In specimens collected from the same locality some faintly mottled seeds were obtained mixed with the uniform-coloured seed. As the flowers of these have not been specially observed, we cannot yet say whether they belong to a new race or not; but, as the two species were frequently found mixed together, they may be hybrids.

Size of seed —

L. 0·2″—0·3″
B. 0·2″—0·3″
T. 0·2″—0·3″

Weight per 100=18·5 gms., or 153 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Kamaing (Bhamo) ...	adaw-pè.	
Bhamo	Do. ...	Mixed with P. arvense.
Mômeik (Katha) ..	Do. ...	Do.
Mandalay	Do.	
Amarapura	Do.	
Ava	Do.	
Pegu	Do. or Hincho-ywêt	(Lit: leaves used for soup).
Hanthawaddy ...	Do.	
S. Hsenwi State ...	Do.	
Pakôkku	Do.	
Kyauksè	Do.	
Myingyan	Do.	
Mônywa	Do.	
Sagaing	Do. or Pè-leikpya.	(Lit: Butter-fly pea).
Chaung-u ...	Do. or Pè-daw.	
Shwebo	Do.	
Lashio	Do.	
Sandoway	Pè-sa-u ...	(Lit: Sparrow's egg pea)
Mohnyin (Katha) ...	Sadaw-pè.	
Hopin (Myitkyina) ...	Do.	

Notes.

In Mandalay, Sadaw-pè is the name given to the uncooked seed, Pè-si-lôn to the cooked seed (boiled, broiled, parched, or roasted) and Pè-leik-pya to the plant itself. In Mômeik (Katha), the name Pè-si-lôn is given to P. arvense, and Sadaw-pè to P. sativum.

We do not think that the distribution list of this pea is by any means complete, as it is found in most places in Burma, at least as a garden crop. As a field-crop, it is cultivated on medium to light soils, especially along the banks of rivers and on the borders of backwaters.

The seed is scattered after the water has receded, at the rate of about one basket per acre, the land being first ploughed or harrowed. This takes place from October to December. No after-cultivation is given, the crop is reaped about February or March and yields 5 to 8 baskets per acre. In other places it is grown as an ordinary cold weather crop, being sown about November. The vines are allowed to trail along the surface of the ground. In parts of Shwebo District, to the west of the Mu river, Sadaw-pè is sown not only on the high lands but, when there is not sufficient rain for a successful paddy-crop, also on the lower-lying paddy fields. The soil is sandy and does not retain water well, and very poor paddy-crops are sometimes ploughed up to be replaced by this pea. The species generally grown here is P. sativum, and it is exported in fairly large quantities. In the Kachin Hills and other hilly districts, P. arvense is sown on taungyas, usually late in the rains. San-to-see in the Kachin Hills is also sown mixed with opium in October. In the Northern Shan States it is cultivated from October to February. In Sandoway it is said to be sown in the rains, but we have been unable to verify this statement.

The leaves, green pods and tender shoots are used in curries such as "heincho" (vegetable soup). The seeds, both in the green and dry states, are eaten as vegetables by all classes. The split peas are used as *dal*. The "straw" is recognised as a valuable feeding-stuff and is made use of by the cultivator. As a field crop, Pisum is already cultivated on a fairly extensive scale and quantities of the seed are annually exported. The price of the dry peas varies from about Rs. 2 to Rs. 2-8 per basket.

The English garden pea is grown as a garden crop largely in the Bhamo District, Myitkyina, Maymyo and other cool parts of the country and near the larger towns.

Glycine hispida, maxim ; (Soy or Soja Bean).

(Syn. *Glycine Soja*, Sieb and Zucc.

Dolichos Soja, Linn.

Soja hispida, Moench.)

Erect to sub-erect, sparsely-branched, annual herbs, from one to two feet in height ; all parts densely clothed with short white to ferruginous hairs. Stems sulcate, somewhat flexuose.

Leaves trifoliolate, stipellate ; *leaflets* membranous, elliptical to ovate-lanceolate, laterals slightly oblique, base rounded, apex acute or obtuse ; *petioles* long, narrow, cylindrical ; *stipules* small, lanceolate ; *stipels* minute ; *racemes* short, usually with 2 to 5 flowers in the axil of the leaves all along the stems and branches ; *pedicels* delicate *flowers* small, white, or purplish (the Burmese varieties grown by us have all pink to purple flowers) ; *calyx* tubular or bell-shaped, teeth unequal, anterior tooth longest ; *bracteoles* ovate acute ; *corolla* exserted ; *standard* hardly reflexed, ovate or sub-orbicular, emarginate ; *wings* narrow, obovate, slightly longer than and enclosing the keel ; *keel* obliquely obovate (sometimes chopper shaped) *staminal tube* sub-cylindrical, very slightly curved ; *stamens* monadelphous, the free ends of the filaments of the united stamens short ; *anthers* uniform ; *style* short, bent forward, glabrous ; *stigma* terminal, surrounded by a fringe of hairs ; *ovary* sessile, hairy ; *ovules* few.

Pods compressed (*S platycarpa*, Harz :), recurved or falcate, broadest at the rounded distal end ; *valves* thin, brown, very hairy, dehiscent.

Seeds few (2 to 4 per pod), oval and sub-reniform or short and sub-spherical, more or less tumid, yellow to black in colour ; *hilum* small, placed about the middle.

The above description is true for all the cultivated Soy Beans found in Burma of which we have recognised the three varieties described below :—

Variety (1) :—

Seeds yellow tinged with brown around the *hilum*, spherical to sub-reniform ; only immature seeds have a greenish tinge.

Race (*i*) :—

Seeds large-medium.

Size of seed :—

L.—0·32″

B.—0·25″

T.—0·18″

Weight per 100 = 10·42 gms., or 278 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Kônmahut (Bhamo) ...	Hto-khyan-pè.	
Northern Shan States (South Hsenwi State).	Pè-ngapi. San-to-tep.	

Race (ii):—

Seeds small-medium, somewhat more spherical than race (i).

Size of seed:—

L.—0·23″
B.—0 2″
T.—0·15″

Weight per 100=6·32 gms., or 448 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Chin Hills (Haka, Tiddim, etc.).	Ber-hrum. Te-hlum. Beir-kan.	
Lashio (and Northern Shan States generally).	Pè-bôk-san. Hsan-to-nouk or To-nouk. Pè-bi-zat*	* Probably a misnomer, generally applied to Dolichos biflorus.
Kachin Hills	Lazi-shaprè-tum.	
Myitkyina (Kachin Hills)	Lasi N'loi. Lasi N'hti.	

Race (iii):—

Seeds very small, somewhat more compressed and darker in colour than Race (ii).

Size of seed:—

L.—0·19″
B.—0·15″
T.—0·09″

Weight per 100=3 gms., or about 960 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Kachin Hills (Bhamo District).	Hto-laung.	
Bhamo	Pè-n gapi.	

Variety (2) :—

Seeds greenish yellow to yellow, tinged with brown around the hilum, almost reniform in shape, somewhat elongated, compressed. The greenish seeds are mostly somewhat immature, though many of them have a greenish tinge even when mature.

Size of seed :—

L.—0·3″
B.—0·2″
T.—0·11″

Weight per 100 = 5·83 gms., or 486 seeds per oz.

Distribution.

Locality.	Local Name.	Remarks.
Chaung-u	Pè-ngapi.	
Mônywa		
Myingyan		
Banmouk (Katha) ...		
Wuntho (Katha) ...		
Pakôkku		
Minbu		
Sagaing		
Mandalay		
Pyapôn		
Madaya	Pè-kyât-pyin.	
Mandalay	Pè-bouk-si.	
Magwè	Pè-bouk.	
Mômeik		

Variety (3) :—

Seeds dull brownish grey to olive brown shading to black around the hilum, medium-sized to large, not compressed.

Size of seed :—

L.—0·32″
B.—0·25″
T.—0·18″

Weight per 100 = 12·06 gms., or 235 seeds per oz.

Distribution.

Locality.	Local name	Remarks.
Maungloi (Kachin Hills)	Ngasee.	

Notes.

The Soy bean is not extensively grown in Burma though its distribution is wide. It is more frequently sown as a subordinate crop than alone. A little is often scattered along with other peas and beans, chiefly along the banks of rivers and streams or on islands after the floods subside In Sagaing District it is frequently grown on paddy nurseries after the young plants have been removed. In Myingyan, Minbu, Pakôkku, Lower Chindwin and Bhamo districts, it is also sown away from the rivers on high sandy soils. Sowing generally takes place about October and the crop is ripe by about February. In Kônmahut (Bhamo District) two crops are sometimes grown—a rainy season crop sown about August and reaped about November and a cold weather crop sown in November and reaped in February. It is here stated that it will grow on any soil where water does not stagnate. In the Kachin Hills, it is dibbled in *taungyàs*, about the beginning of the rains, along with paddy. In the Northern Shan States it is chiefly sown about July, but it is stated that it may be sown at any time, when weather-conditions are favourable, from the beginning of the rains up to December. In Wuntho (Katha) and in Magwè district it is also sown at any time from June to November, in the latter district it is sown on Yá lands. Very little care is bestowed upon its cultivation ; the seed is scattered at the rate of $\frac{1}{8}$ to $\frac{1}{4}$ basket per acre after which very little attention is given to the crop. The yield is poor and varies from 4 to 12 baskets per acre.

Pè-ngapi is used for a variety of purposes. After being steeped in water, fermented and cured it is used under the name of "Kyá-nyo", "pè-bouk-yè," or "pè-ngán-byá-yè" as a sauce for flavouring food and takes the place of "ngapi" (Burmese rotted fish) where the latter cannot be easily obtained. For this purpose, considerable quantities of the bean are utilized in the plains and the product carried to other parts, particularly to the Northern Shan States. A similar product is made by Chinamen in parts of Mandalay but for this purpose the Manchurian Bean is frequently imported. The method is as follows:—The seeds are sorted and placed in large steel or iron cauldrons with sloping sides, 6 or 8 feet diameter at the rim and 2 feet deep. Water is added and the mass is boiled until the beans are soft and nearly all the water has evaporated. It is then mixed with a sufficient quantity of wheat flour to make it so thick that it can be freely handled. It is then spread out, in the shade, on shelves made of bamboo matting, till dry. In the meantime, a concentrated solution of salt and water is prepared. This solution is concentrated by boiling until crystals appear or until it reaches such a density that "an egg

will not sink in it". The dry material is then steeped in this brine in earthenware vessels which are open to the air and are usually placed in a backyard. The mass is here allowed to ferment and is said to remain often as long as a year. When fermentation has proceeded far enough, which is ascertained by tasting, the dark reddish-brown liquid is decanted off, bottled and sold. The residue is made into small flat cakes called "pè-bôk" which are used for flavouring curries and soups. The whole beans are also said to be made into similar cakes, also called "pè-bôk", by the Shans of the Northern Shan States for sale to caravans, and it is further stated that one small cake is sufficient for a meal.

Attempts have been made to introduce foreign Soy beans into Burma but with no success. Although they will grow, a profitable yield cannot be obtained and the oil-content rapidly decreases. The Chinese who import the bean from China state that the climate of Burma is not suitable for the production of Soy beans of good quality: hence they are forced to import them at a cost of somewhere about Rs. 20 per bag of three baskets (Burmese).

The quantity of oil found in the Burmese Soy beans is usually about 12 to 14 per cent., though it varies considerably in the different varieties. This quantity, it will be noticed, is considerably lower than that found in most foreign varieties, such as those obtained from Manchuria, Japan and America. Many chemical analyses of Burmese Soy beans have been made but we do not think it necessary to include them in this work.

Soy bean cultivation could easily be extended in many districts and the crop might take the place, to a great extent, of pè-gya which now occupies the bulk of the island areas and is regarded with suspicion in European markets on account of the Prussic-acid forming glucosides which the beans sometimes contain.

Canavalia ensiformis, DC. The Sword-bean.

Extensively-twining biennials or perennials with terete glabrous stems and branches.

Leaves trifoliolate, minutely stipellate; *stipules* short, triangular, thick; *stipels* minute; *leaflets* large, entire, ovate-acute, membranous; *laterals* only slightly oblique; *laminæ* flat or rugose and crumpled between the veins; *petioles* cylindrical.

Peduncles up to 6″ in length; *flowers* conspicuous, solitary or in pairs on the tumid (hemispherical) nodes; *bracteoles* minute, ovate, caducous; *calyx* gibbous, tubular or bell-shaped, constricted at the mouth where it is divided into two lips the anterior of which is unequally 3-toothed and the posterior entire or 2-cleft, rounded and projecting; *corolla* much exserted; *standard* orbicular, emarginate (sometimes deeply), as long as, sometimes slightly longer than, the wings and keel, white or pink fading to blue; *wings* equal in length to the keel, laterally crumpled; *keel* obtuse, evenly curved inwards; *stamens* monadelphous (the posterior stamen being free only at the base), staminal tube arched not elbowed; *anthers* versatile, uniform; *style* beardless; *stigma* terminal; *ovary* stipitate.

Pod up to 10″ in length, 2″ in breath, and about 0·75″ in thickness, oblong, turgid, retuse to sub-retuse or uniformly curved at the distal end, dehiscent,—the dehiscence being sometimes preceded by the exfoliation, in one piece, of a strip of fibrous tissue from the face of the ventral suture; *valves* stiff, woody, with a conspicuous ridge or shallow wing on each side of the ventral suture.

Seeds 6 to 12 in number (at right angles to the axis of the pod) ovoid and flattened, or sub-cylindrical, sometimes depressed anterio-posteriorly, white, deep red, or yellow mottled with brown; *hilum* usually long, narrow, sometimes depressed, yellow or brown.

Variety (1):—

Flowers white, petals equal or sub-equal.

Pods large and broad (usually about 6″ to 10″ long and 1·5″ to 2″ broad).

Seeds large, *hilum* almost as long as the seed.

Size of seed:—

L. 0·9″—1·35″

B. 0·5″—0·7″

T. 0·4″—0·5″

Weight per 100=285·6 gms., or 10 or 11 seeds per oz.

Race (1):—

Seeds deep red.

Distribution.

Locality.	Local name.	Remarks.
Amarapura	Pé-dalêt. or Pè-dalêt-ani.	
Choung-u (Sagaing) ...		
Mônywa		
Rangoon (Hanthawaddy)	Pè-dalêt-ani.	
Magwè	Pè-dalêt.	

Race (ii) :—

Seeds pure white.

Distribution.

Locality.	Local name.	Remarks.
Akyab	Pè-dêt or Pè-damouk.	
Moulmein	Pè-damah.	
Chin Hills	Rar.	
	Rar-hte.	
	Bu-shol.	
	Kwè-è.	

Variety (2) :—

Flowers pink, petals equal or sub-equal.

Pods medium in size (up to 6″ in length and 0·75″ in breadth).

Seeds medium-sized, dull yellow mottled with brown, *hilum* only about half the length of the seed.

Size of seed :—

L. 0·65″—0·7″
B. 0·4″—0·5″
T. 0·3″—0·4″

Weight per 100=91·6 gms., or 30 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Pè-dalêt.	

Notes.

The above varieties of Canavalia ensiformis are cultivated to a small extent, chiefly in gardens. The seeds are sown about the beginning of the rains and the plants are allowed to twine over fences, bamboo trellises, etc., near houses. The young pods make a delicate vegetable and are eaten, after being steeped in hot water, with "*Ngapi*" or they are made into "*hincho*" (thick soup). The seeds are seldom eaten but are used for medicinal purposes. Variety 2 is found wild as well as under cultivation; and of this variety the tender seeds are also consumed.

The white race of Variety 1 is the common form grown in the Chin Hills. The bean, in its raw state, is said to be poisonous, and before cooking, the Chins soak it in running water for five days. The pods are allowed to remain on the plant till quite dry after which they are plucked, and the seed removed and stored.

Canavalia, sp.

A bushy plant (non-twining), 3′ or 4′ high, bearing large leaves with ovate to ovate-oblong leaflets.

Flowers pink to purple, similar to Canavalia ensiformis, but *wings* shorter than the keel or standard.

Pods much narrower than Canavalia ensiformis (length 6″ or 10″ breadth 0·75″ to 1″).

Seeds medium-sized, oval, pure white and laterally compressed; *hilum* extending to about half the length of the seed only.

Size of seed: —

L. 0·7″
B. 0·5″
T. 0·3″

Weight per 100=117 gms., or 24 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Tayôk-pè.	
Kyi-kôn (Sagaing) ...	Bo-sa-pè.	

Notes.

This plant is said to live two years and to bear profusely. It is popularly supposed to have been introduced by the Chinese: hence the name "Tayôk-pè." We have only found the plant in two localities where it is said to be only occasionally cultivated, but it probably has a much wider distribution. In Mandalay it is grown as a garden crop and the young pods are very much appreciated as a vegetable. They are tender, succulent, and similar to French beans in taste. Near Choung-u (Sàgaing) it is also grown as a field crop to a limited extent. The mature seeds, after soaking, are boiled and eaten in the same way as *pè-gyi* (See under Dolichos Lablab).

Mucuna pruriens, DC. var: utilis, Wall.

(Syn. Stizolobium, sp.)

The Velvet-bean.

Twining annuals with slender terete stems and branches which are pubescent when young and glabrescent when mature.

Leaves trifoliolate; the *prophylls* splashed, near the principal veins, with irregular patches of pale grey or bluish-purple; *leaflets* membranous, flat, tomentose, entire, mucronate, bases rounded; terminal leaflet sub-elliptical to rhomboidal; laterals oblique; *petiole* slender, cylindrical; *stipules* and *stipels* small, lanceolate.

Racemes axillary, short-peduncled, few-flowered; nodes of racemes tumid; *flowers* large, bluish-purple in colour; *calyx* large, campanulate, frequently velvety, yellowish-white; the two upper teeth connates forming a broad triangular lip, lateral teeth lanceolate, equal in length to the tube, lowest tooth the longest; *corolla* much exserted, petal, very unequal; *standard* ovate acute, slightly reflexed, about half the length of the wings and keel; *wings* oblong-elliptical; *keel-petals* united to form a tube, the incurved rostrate apex of which is usually exserted beyond the wings; *staminal tube* arched near the base and erect in the open flower; *stamens* diadelphous (9 + 1); *anthers* dimorphous; the bundle of 9 stamens in two whorls, the filaments of the outer whorl of 5 cylindrical with long anthers, those of the inner 4 flattened and clavate with short anthers; *style* filiform, beardless; *stigma*; capitate; *ovary* sessile.

Pods about 3″ in length and 0·75″ in breadth, apex blunt and rostrate, slightly constricted (laterally) between the seeds, septate (obliquely), indehiscent; *valves* stiff, ridged (laterally) and wrinkled, velvety with a white to golden-brown pubescence.

Seeds 3 to 6 per pod, ovoid, tumid or slightly flattened, *hilum* conspicuously-ridged, aril-like, protruding above the middle of the seed.

Size of seed :—
L.—0·68″
B.—0·45″
T.—0·3″

Weight per 100 = 109 gms., or 26 seeds per oz.

The following 3 races are utilized :—

Race (*i*) :—

Seeds dull white to light grey.

Distribution.

Locality.	Local name.	Remarks.
Chin Hills	Ra (Chin) ... / Aung lauk (Chinese).	Also received mixed with Race (ii) under the name of Bu-shule.
Madaya	Gwè-ngè-pè. / Khwè-lè-pè.	
Shan States	Khwè-lè-pè.	
Sagaing		
Thayetmyo		
Toungoo		
Tharrawaddy ...		

Race (*ii*) :—

Seeds dark brown or chocolate, mottled with grey.

Distribution.

Locality.	Local name.	Remarks.
Chin Hills	Ewe-shewl. Bu-shule or Yom-nung.	

Race (*iii*) :—

Seeds jet black, lustrous.

Distribution.

Locality.	Local name.	Remarks.
Akyab	Pè-dèt-anèt. Kwè-yè-pè.	

Notes.

Although we have named this species *Mucuna pruriens, var : utilis*, it is now being classed by some authorities in a separate sub-section, under the genus *Mucuna*, as *Stizolobium*. Moreover, the description of *M. capitata, W. & A.* in Hooker's Flora of British India so closely conforms to that of *M. pruriens, var : utilis* that from the characters shown by our specimens, they might easily be placed under the former species.

In the Chin Hills, whence many of our specimens were derived, the name *Ra* or *Aung-lauk* appears to be generally given to the white-seeded Race (i) and *Ewe-shewl* or *Bu-shule* to the mottled Race (ii).

The Velvet-bean is cultivated in Burma, chiefly in the hill-tracts, to only a small extent in gardens where it is allowed to trail over houses and fences. In Akyab, the black-seeded race is said to be sown at the rate of two baskets per acre on "Khine" or "Ya" lands; it is, however, more frequently self-sown, the plant springing up in the rains and the pods ripening in the cold weather. It is stated that the young and tender pod is eaten by some people in curries. The seed, so far as we know, is used only in medicine. In the *Tropical Agriculturist*, August 1910, page 167, it is stated that "the Velvet-bean is used for fattening cattle. It can be eaten without injury but it is liable to have unpleasant purging and vomiting effects if taken in any serious quantity."

The cultivation of this bean in the plains is, according to the cultivators, comparatively recent; but in the hills, it would seem to be more ancient and more permanent, though our information on this particular matter is limited. It is possible that the varieties now cultivated in the plains, where very few people appear to recognise its value, were derived from the hills. In Akyab, the black-seeded race appears to exist in a semi-wild state, whilst the common wild variety of *Mucuna pruriens* is a familiar jungle plant throughout the greater part of the country.

Phaseolus.

Erect, sub-erect, trailing, or twining annuals or perennials, with grooved or terete stems and branches which are usually hairy but sometimes glabrous.

Leaves trifoliolate; *leaflets* ovate to triangular, entire or lobed, acute to caudate, retuse or sub-deltoid; *laterals* oblique; *venation* fine but distinct and sometimes prominent; *laminae* membranous, sub-glabrous or hairy; *stipules* variable in size, ovate-lanceolate, triangular, cordate or auriculate, attached by the base or below the middle; *stipels* small, ovate, linear-lanceolate, sessile.

Peduncles stout or slender; *racemes* axillary, lax or capitate, sometimes very congested; *pedicels* delicate; *bracteoles* usually conspicuous, sessile, persistent, ovate or lanceolate; *calyx* campanulate, anterior tooth the longest; *corolla* exserted; *standard* reflexed; *wings* contorted about the spiral and beaked *keel*; *stamens* diadelphous; *anthers* uniform; *style* filiform, twisted round with the keel, bearded on the inner curve; *stigma* very oblique; *ovary* sessile, many ovuled.

Pods broad, more or less recurved and laterally flattened (lunate to sub-lunate), or linear, cylindrical, terete, or torulose, with more or less distinct rostra, sub-erect, horizontal, or pendulous, glabrous to hairy, septate, dehiscent.

Seeds flattened, cylindrical, reniform or subreniform, retuse or rounded at the ends, and varying very greatly in colour.

Notes.

The Genus Phaseolus is very widely distributed and extensively cultivated. It includes a number of the most important species cultivated as field crops in Burma. It comprises many valuable forms which are highly esteemed for food purposes and for export; and also a number of forms which are restricted to special localities.

Key to Species of Phaseolus.

(*a*) *Stipules minute, basifixed*: *pods broad, sub-compressed*:—

Racemes lax:—

Racemes short-peduncled, many-flowered;

Petals small, greenish-yellow;

Bracteoles minute;

Pod recurved, oblong (scimitar-shaped)——*Phaseolus lunatus* (A).

Racemes sub-sessile, few flowered;

Petals medium-sized, pink to purple;

Bracteoles often exceeding the calyx;

Pod linear, more or less straight—*Phaseolus vulgaris* (B).

(*b*) *Stipules conspicuous, prolonged below point of insertion*; *pods narrow, sub-terete*:—

(*i*) *Racemes capitate*:—

Stems slender, procumbent, glabrous or slightly hairy;

Stipules oblong;

Leaflets tri-lobed;

Flowers minute;

Pods glabrescent——*Phaseolus trilobus* (C).

Stems erect or sub-erect, densly clothed with deflexed hairs;

Stipules ovate;

Leaflets entire;

Flowers medium-sized;

Pods pubescent——*Phaseolus Mungo* (D).

(*ii*) *Racemes not capitate*:—

Stems sub-erect and often flexuose, clothed with fine deciduous, deflexed hairs:—

Stipules lanceolate;

Leaflets entire or faintly lobed;

Flowers medium-sized to large;

Pods glabrous——*Phaseolus calcaratus* (E)

Key to the Varieties and Races of Phaseolus.

A.—Phaseolus lunatus.

Variety (1) :—

Pods small, evenly curved throughout.
Seeds irregularly reniform or obliquely retuse, tumid to sub tumid, seldom flattened laterally.

Sub-variety (*a*) :—*Seeds* light brown to purple, plain or mottled.

Sub-variety (*b*) :—*Seeds* very tumid, deep purple.

Sub-variety (*c*) :—*Seeds* pure white.

Variety (2) :—

Pods larger (than Variety 1), slightly curved, very abruptly hooked at apex.

Seeds large, reniform, much flattened laterally.

Sub-variety (*a*) :—*Seeds* with white branched markings radiating from the *hilum.*

Race (i) :—

Seeds red with white markings.

Race (ii) :—

Seeds black with white markings.

Sub-variety (*b*) :—*Seeds* deep reddish purple.

Variety (3) :—

Pods broad very slightly curved, almost straight.
Seeds very large.

Sub-variety (*a*) :—*Pods* retuse at the apex.
Seeds somewhat tumid, pale green streaked and splashed with deep red.

Sub-variety (*b*) :—*Pods* somewhat retuse at the apex.
Seeds reniform, much flattened laterally, pure white.

Sub-variety (*c*) :—*Pods* pointed at the apex.
Seeds much flattened laterally, long-reniform, white, tipped at the end (or splashed throughout) with red.

B.—Phaseolus vulgaris.

Variety (1) :—

Pods elongated, flattened, long beaked.
Seeds long sub-cylindrical to reniform.

Sub-variety (*a*) :—*Seeds* large, long-reniform, deep red.

Sub-variety (*b*) :—*Seeds* large, long-reniform, white (often streaked with red down the ventral edge).

Variety (2) :—

Pods shorter, broader and more tumid than Variety 1 narrowing to the basal end.
Seeds medium-sized, short.

Sub-variety (*a*) :—*Seeds* jet black.

Sub-variety (*b*) :—*Seeds* red to speckled.

C.—Phaseolus trilobus.

Variety (1) :—
Pods almost cylindrical, horizontal or slightly drooping.
Seeds with a seam on the dorsal edge, green mottled with black.

D.—Phaseolus Mungo.

Variety (1) :—
Phaseolus Mungo proper :—
Plants tinged with red throughout.
Leaflets of upper leaves lanceolate, of lower broadly ovate.
Pods short, blunt-pointed, borne vertically.
Seeds 6 to 10, black (mottled with greenish-brown under magnification), testa smooth.

Variety (2) :—
Phaseolus Mungo, radiatus :—
Plants green throughout.
Leaflets all broadly ovate.
Pods long, sharp-pointed, borne horizontally.
Seeds 10 to 15, small, green, yellow or black, testa striate.
Sub-variety (*a*) :—*Seeds* dull green.
Sub-variety (*b*) :—*Seeds* yellow to light brown.
Sub-variety (*c*) :—*Seeds* dark-brown to black (mottled with greenish-brown under magnification).

E.—Phaseolus calcaratus.

Variety (1) :—
Stems short, stout, erect to sub-erect.
Race (*i*) :—
Seeds grey or brown speckled with black.
Race (*ii*) :—
Seeds chocolate-red mottled with black.

Variety (2) :—
Stems slender, twining.
Race (*i*) :—
Seeds pale yellow to dark brown.
Race (*ii*) :—
Seeds jet black.

A.—Phaseolus lunatus, L ; Lima or Duffin-bean.

Twining annuals, biennials or perennials with grooved stems and branches ; all parts more or less glabrous ; young parts sometimes minutely downy.

Leaves trifoliolate ; *terminal leaflets* broadly ovate-triangular, acute or acuminate ; *laterals* broadly ovate, oblique, sub-deltoid ; *stipules* minute, basifixed, broadly triangular ; *stipels* minute, sessile.

Peduncles short ; *flowers* many ; *calyx* minute, campanulate, teeth all very short ; *corolla* small (3 to 4 times the calyx), greenish-yellow to white (*standard* generally pale green, *wings* white) ; *bracteoles* minute, not more than half the length of the calyx, sessile ; *keel* prolonged into a complete spiral.

Pods oblong, generally recurved, but sometimes the recurvature is slight.

Seeds medium-sized to large, variable in shape, but all having peculiar branched faint lines or veins radiating from the *hilum* to the outer edge. (These lines appear on the testa like the translucent water-marks on writing paper). In the *Pè-leik-pya* class, the lines develop into striking patterns of strongly contrasting colours.

" *Phaseolus lunatus* is easily distinguished from other species by the shape of the pod which is less turgid than any of the others, the upper suture is recurved and the lower broadly rounded." (Hooker's Flora of British India).

Variety (1) :—

Pods small, more or less sickle-shaped and evenly curved throughout their length ; they are 1·25″ to 2·5″ in length and 0·4″ to 0·75″ in breadth.

Seeds irregularly reniform to obliquely retuse, tumid to sub-tumid, seldom laterally flattened, and varying in colour from white to deep purple ; they are also often marbled or mottled.

Sub-variety (*a*) :—*Seeds* light brown to red or purple, plain or mottled.

Size of seed :—

L. 0·3″ to 0·5″
B. 0·3″ to 0·4″
T. 0·2″ to 0·25″

Weight per 100=31·5 gms., or 90 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Hanthawaddy ...	Pè-gya.	
Thatôn		
Tharrawaddy		
Pegu		
Toungoo		
Minbu		
Shwebo		
Pakôkku		
Mônywa (Lower Chindwin)		

Distribution.

Locality.	Local name.	Remarks.
Upper Chindwin ...	Pè-gya.	
Magwè		
Katha		
Henzada		
Kyauksè		
Mandalay	Ranga-daing ...	Pounna name (Pounna = A Manipuri Brahmin).
Ywadan (Yamèthin) ...	Pè-gya or	
Meiktila	Pè-san-tagu,	
Mandalay	Pè-gya, Pè-ni	
Sagaing	or Shan-Pè.	
Choung-u (Sagaing) ...	Pè-gya-ni.	
	Pè-zun.	
Mônywa	Pè-gya-ni.	
Myingyan	Pè-san-tagu-a-ni.	
Pegu	San-tagu-pè.	
Chin Hills	Tum-ran.	
	Kawl-be.	
	Kal-beir-kan.	
Akyab	Pè-bra.	

Sub-variety (*b*) :—

Seeds very tumid (often almost spherical), retuse, deep purple in colour.

Size of seed :—

L. 0·3″—0·45″
B. 0·25″—0·3″
T. 0·2″—0·3″

Weight per 100=30·81 gms., or 92 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Chin Hills	Tim Sin.	

Sub-variety (*c*) :—

Seeds shaped like *Sub-variety* (*a*) but pure white in colour.

Size of seed :—

L. 0·3″—0·5″
B. 0·25″—0·35″
T. 0·2″—0·3″

Weight per 100=24·43 gms., or 116 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Hanthawaddy ...	Pè-byu-galè.	
Mandalay		
Sagaing		
Amarapura		
Choung-u (Sagaing) ...		
Shwè-pyi (Mandalay) ...		
Mônywa		
Mandalay	Shân-pè.	
	Pounna-pè.	
	Dup-daing ...	The Pounna name (Pounna. = A Manipuri Brahmin)
Mômeik (Bhamo) ...	Pè-byu-galè ...	Mixed.
Minbu	Pè-san-tagu.	
Meiktila		
Myingyan	Pè-san-tagu-a-pyu.	

Variety (2) :—

Pods generally only slightly curved throughout their length but abruptly curved at the apex to form a hook ; they are larger than those of Variety 1, being 3″ to 4″ in length and 0·75″ to 1″ in breadth.

Seeds large (much larger than Variety 1) reniform, much flattened laterally.

Sub-variety (*a*) :—

Seeds with white branched markings which form a pattern radiating from the hilum.

Size of seed:—

L. 0·5″—0 7″
B. 0·3″—0·55″
T. 0·15″—0·2″

Weight per 100 = 52·5 gms., or 54 seeds per oz.

Race (*i*) :—

Seeds red with white markings.

Distribution.

Locality.	Local name.	Remarks.
Hanthawaddy ...	Pè-leik-pya.	
Amarapura ...	Talôk-pè.	

Race (*ii*) :—

Seeds black with white markings .

Distribution.

Locality.	Local name.	Remarks.
Belin (Kyauksè) ...	Pè-leik-pya.	
Shwè-pyi (Mandalay) ...		

Sub-variety (*b*) :—

Seeds deep reddish purple.

Size of seed :—

L. 0·4″ to 0·6″
B. 0·3″ to 0·45″
T. 0·2″ to 0·25″

Weight per 100=44·3 gms., or 64 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
South Hsenwi State (Northern Shan States).	Bò-sà-pè.	

Variety (3) :—

Pods broad, very slightly curved (almost straight) length 3″ to 4″, breadth about 1″.

Seeds very large.

Sub-variety (*a*) :—

Seeds somewhat tumid, pale green, splashed and streaked with deep red.

Pods retuse at the apex.

Size of seed :—

L. 0·5″—0·75″
B. 0·45″—0·58″
T. 0·25″—0·35″

Weight per 100=123·26 gms., or 23 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
South Hseinwi State (Northern Shan States).	Pè-gya.	

Sub-variety (*b*) :—

Seeds reniform, much flattened laterally, pure white.
Pods somewhat retuse at the apex.
Size of seed :—

L. 0·7″ to 0·95″
B. 0·4″ to 0·65″
T. 0·2″ to 0·25″

Weight per 100=128·8 gms., or 22 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Myitkyina (Kyun-bin-tha village.)	Pè-wôt-cheik-lein.	
	Pè-byu-gyi ...	True Lima or Madagascar Bean.
Yawnghwe (Southern Shan States)	Do. ...	Seeds smaller than those from Myitkyina.

Sub-variety (*c*) :—

Seeds much flattened laterally, long-reniform, white, tipped at one end with red or splashed with red throughout.
Pods pointed at the apex.
Size of seed :—

L. 0·7″—1·1″
B. 0·45″—0·65″
T. 0·2″—0·25″

Weight per 100=118·12 gms., or 24 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Choung-u (Sagaing) ...	Pè-gya.	

Notes.

Phaseolus lunatus is one of the most widely distributed beans found in Burma, being spread throughout almost every district, though it is extensively cultivated only in a few districts, such as Sagaing, Lower Chindwin, Meiktila and Myingyan. The two most commonly cultivated types are *Pè-gya* [Var. 1, Sub-var. (*a*)] and *Pè-byu-gale* [Var. 1, Sub-Var. (*c*)]. The other types are seldom, if ever, cultivated as field crops. *Pè-gya* and *Pè-byu-gale* frequently go under the names

of "Rangoon Red Beans" and "Rangoon White Beans," but the latter term is also often applied to *Pè-gyi* [*Dolichos Lablab*, Var. 1, Sub-var. (*a*) Race (*i*)].

A great deal has been written, from time to time, on the poisonous properties of Rangoon beans, owing to the presence in them of glucosides, and the matter has lately been again brought to our notice. There seems to be considerable variation in the percentage of the poisonous principle contained in these beans but the conditions most favourable to its development have yet to be investigated. It would appear that *Pè-gya* [Var. 1, Sub-var. (*a*)] is the chief, if not the only type, which contains these prussic-acid-forming glucosides to any dangerous extent. The white types are recommended for cultivation by the Director of the Imperial Institute, as being less dangerous for consumption, and it is suggested that the amount of prussic-acid contained in the beans may depend to some extent at least on the methods of cultivation and the degree of maturity at harvest. The opinion of the Burman cultivator is that the haulms of *Pè-gya* and *Pè-byu-gale*, when dry may be fed to cattle with perfect safety, but that when fresh, and particularly when in flower, they are a dangerous food and often cause death——cattle eating them are said to die by the evening of the day on which they eat them. The beans themselves are not eaten raw but boiled or parched, which is probably the reason why we hear of no fatalities among Burmans following their consumption. For further information on the subject of toxicity of these beans, the reader is referred to *Agricultural Ledger*, 1905, No. 2, Bulletin of the *Imperial Institute*, 1903, Nos. 1, 15, 122 and 1905 Nos. 3, 373, *Journal of the Board of Agriculture*, 1908, Nos. 14, 722, *Journal of the Society of Chemical Industry*, 1908, Nos. 27, 428.

The time and method of cultivation varies very considerably. In the hills the beans are frequently sown at the beginning of the rains, or in *Yas* from September to January. In the plains they are most generally sown from August to December and reaped from February to April. On islands and flooded areas along rivers they are sown after the floods subside, *i.e.*, from September to December. They are generally sown by dropping the seeds, at the rate of about half a basket per acre, in furrows made by the plough. This method results in the plants growing more or less in rows 1 to 1½ feet apart. Frequently, however, the seed is scattered and harrowed in or it is sown broadcast, mixed with maize, at the rate of about half a basket of *Pè-gya* or *Pè-byu-gale* to ⅛ of a basket of maize per acre. The maize affords support for the climbing beans. If sown alone, about ¾ basket is scattered per acre. One or two weedings, are generally given, but the crop trails over the ground, grows thickly and, to a large extent, suppresses the smaller weeds. The crop generally takes about five months to come to maturity and is then reaped with the *tazin* (sickle) and threshed by bullocks in the ordinary way. *Pè-gya* will yield from 12 to 20 baskets per acre while *Pè-byu-gale* yields about 15. These two varieties are said to prefer a clay loam to sandy soil.

Varieties 2 and 3 are almost entirely garden plants, sown at any time during the rains and allowed to trail over fences, huts, or trellises.

The pods of *Phaseolus lunatus* are not consumed but the tender seeds are frequently eaten after being boiled. Most generally, however,

only the ripe seeds are eaten. The favourite method is to first sprout the seed and then to cook it, but it is also parched, boiled, or roasted without sprouting.

Variety 1 only is available for export from many districts of Central Burma, chiefly Myingyan (44,000 acres), Lower Chindwin (28,000 acres), Sagaing (26,000 acres), and Meiktila (24,000 acres). The price of *Pè-gya* varies from annas 12 to Re. 1-4 per basket, whilst that of *Pè-byu-gale* is usually 4 annas or so, per basket, higher. The crop is bought by brokers who consign to Rangoon whence the beans are exported to Europe and elsewhere. In Lower Burma and the hill tracts Phaseolus lunatus is not grown to any extent.

We have given the name Lima or Duffin Bean to Phaseolus lunatus, but, generally speaking, in commercial circles the term "Lima Bean" is applied to the larger and plumper varieties which are white or nearly white. They are generally much larger than the Rangoon bean and are produced in many tropical countries and, to some extent, in the south of France. The cultivation of the true Lima Bean [Variety 3, Sub-variety (*b*)] is now spreading in Burma and it appears likely that it will eventually replace, to a large extent, the less desirable *Pè-gya* and *Pè-byu-gale*. Quantities of seed have been distributed in several districts particularly where there is island or "kaing" cultivation, *e.g.*, Mandalay, Sagaing, Myingyan, Pakôkku, etc.

B.—Phaseolus vulgaris, L. Haricot-bean.

Erect or sub-erect annuals with all parts sub-glabrous.

Terminal leaflet ovate, acuminate; *laterals* obliquely ovate; *stipules* small, ovate, acute, basifixed; *stipels* minute, lanceolate.

Flowers in short-peduncled, few-flowered racemes; flowers medium-sized; *corolla* pink to purple; *bracteoles* large, leafy, as long as or exceeding the length of the calyx.

Pods linear or elongated (narrower than in P. lunatus) laterally flattened though turgid, long beaked, up to 6″ in length and 0·5″ in breadth, valves somewhat fleshy.

Variety (1):—

Pods elongated, straight, much flattened and long-beaked, green; length 5″ to 6″, breadth 0·4″ to 0·6″.
Seeds long, sub-cylindrical to reniform, *hilum* small.

Sub-variety (*a*):—

Seeds large, long-reniform, deep red in colour.

Size of seed:—

L. 0·6″—0·9″
B. 0·3″—0·4″
T. 0·2″—0·3″

Weight per 100=54·51 gms., or 52 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Bhamo	Bó-sá-pè.	
South Hsenwi State ..	Pè-doung-shè.	

Sub-variety (*b*) :—

Seeds large, long-reniform, white, often streaked with red down the ventral edge.

Size of seed :—

L. 0·5″—0·85″

B. 0·25″—0·4″

T. 0·2″—0·3″

Weight per 100=56·7 gms., or 50 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Bhamo	Bó-sá-pè-apyu.	
Taunggyi	To Tôk (Shan) ...	A smaller seed than that of the Bhamo variety.

Variety (2) :—

Pods shorter, broader, and more tumid than Variety 1, narrowing somewhat to the basal end, frequently streaked with purple; length 3·5″ to 4″, breadth 0·5″ to 0·7″.

Seeds medium-sized, shorter than those of Variety 1.

Sub-variety (*a*) :—*Seeds* jet black.

Size of seed:—

L. 0·4″—0·5″

B. 0·25″—0·3″

T. 0·2″—0·25″

Weight per 100=21·5 gms., or 131 seeds per oz

Distribution.

Locality.	Local name.	Remarks.
Maymyo	Bó-sá-pè.	
Sagaing		
Mandalay		
Shwebo		
Thayetmyo		
Akyab		
Moulmein		
Hanthawaddy... ...		
Tiddim (Chin Hills) ...	Mete-beir.	
Taunggyi	Name not given.	

Sub-variety (*b*) :—
Seeds red to speckled.

Size of seed :—

L. 0·45″—0·65″
B. 0·3″—0·35″
T. 0·2″—0·25″

Weight per 100=34·4 gms., or 83 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mungloi (Kachin Hills) ...	Hkain-u-shaprè.	
Northern Shan States ...	Pè-ta-lá, or Ta-lá-pè	
Southern Shan States ...		

Notes.

P. vulgaris generally goes by the name of Bó-sá-pè (the pea which the European eats) and is cultivated in many places but chiefly as a market-garden crop, in the vicinity of towns, and not for export. It

the Shan States, Chin Hills and other hilly districts it is sown early during the rains but on the plains it can be grown only in the cold weather. In the Kachin Hills "Hkain-u-shaprè" is sown about May or June, mixed with maize in Taungyas. It twines to a certain extent and the maize is said to act as a support. Considerable care is bestowed on the cultivation. It is often heavily manured, sown in rows and carefully weeded. Near towns, where it is sold as a "Kidney" or French Bean it yields very good profits.

The green pods of all the varieties are utilised as a vegetable, and are appreciated as much by Burmans and others as by Europeans, whilst the ripe seeds are also consumed. In Bhamo District, both Sub-varieties of Variety 1 are very largely cultivated—to some extent even as field crops—and the seeds are available for sale in fairly large quantities, at the rate of about Rs. 4 per basket.

Round Mandalay and Maymyo Variety 2, Sub-variety (*a*) is more largely cultivated and, to some extent, is transported from one locality to another, as for example the Northern Shan States to Mandalay Bazaar.

C.—Phaseolus trilobus, Ait.

(Wild)

Slender, diffuse, trailing, slightly hairy, herbaceous perennial plant.

Leaflets trilobed, lobes variable, but usually short and broad, rhomboid or ovate; *stipules* large, ovate-cordate, acute, attached near the base; *stipels* small.

Peduncles long (often more than a foot in length) arising perpendicularly from the creeping stems; *racemes* capitate; *fertile flowers* few (the number of flowers borne on a peduncle is numerous, but very few—seldom more than 2—are fertile); *bracteoles* large, ovate, longer than the calyx-cup; *flowers* small, yellow; *pedicels* very short; *calyx* campanulate, pale yellow; *teeth* deltoid; *corolla* less than 0·25″ long.

Pods one to three per peduncle, almost cylindrical, black when ripe, covered with minute distant white hairs which are red on the green pod, septate, almost horizontal (slightly drooping), length about 1″, thickness 0·125″; 6-to 12-seeded.

Seeds almost cylindrical, retuse to sub-retuse, green mottled with black, with a delicate seam along the dorsal edge (a character not observed in any other Phaseolus).

Size of seed:—

L. 0·1″—0·13″
B. 0·08″—0·1″
T. 0·06″—0·09″

Weight per 100=1·1 gms., or 2,577 seeds per oz.

Notes.

This plant is wild in most parts of Burma. It is not generally cultivated, but is used for fodder purposes, and is regarded by the cultivator as excellent for this purpose. The seeds are also well known to be edible and are sometimes collected and eaten by the Burmese.

D.—Phaseolus Mungo, Linn.

Small erect to sub-erect annual densely clothed with loose, deflexed silky hairs; height of plant usually from 1 to 2 feet.

Leaflets entire, membranous, hairy; *stipules* ovate acute, auriculate, inserted above the base; *stipels* falcate, lanceolate, acuminate.

Racemes capitate; *bracteoles* lanceolate, as long as or longer than the calyx-cup; *flowers* medium-size, yellow; *pedicels* very short; *calyx* 0·125″ to 0·16,″ lower tooth deltoid or lanceolate; *keel* strongly falcate, tip obtuse.

Pods cylindrical to terete, clothed with long, spreading, deciduous, silky hairs and born in fascicles of 2 to 6 per peduncle, only slightly recurved, 6-to 15-seeded.

Variety 1.—Phaseolus Mungo, proper, Linn.

Plants tinged with red throughout and covered with white silky hairs.

The *leaflets* of the upper leaves are lanceolate—the terminals oblong-lanceolate, the laterals more ovate-lanceolate and oblique; the leaflets of the lower leaves are broadly ovate, the laterals being oblique; *bracteoles* twice as long as the calyx.

Pods comparatively short, broad (2″ to 2·5″ in length and up to 0·25″ in breadth), blunt-pointed, borne more or less vertically (never at right-angles to the peduncle, *i.e.*, never radially), near the end of the peduncle, usually in twos or threes; hairs longer and more numerous than in Variety 2, but grey or white in colour (not ferruginous).

Seeds 6 to 10 per pod, short-cylindrical, retuse; appearance of seed in bulk, black, but when examined closely or under magnification, it is black mottled with greenish brown; *hilums* small but prominent; *testa* smooth.

Size of seed:—

L. 0·14″ to 0·2″

B. 0·13″—0·18″

T. 0·13″—0·18″

Weight per 100=382 gms., or 742 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Mât-pè.	
Kyauksè		
Tazè (Mu River) ...		
Sagaing		
Pakôkku		
Myingyan		
Minbu		
Magwè		
Mônywa	Mât-chwè.	

Notes.

Mât-pè is generally cultivated in the cold weather, being sown at the rate of about $\frac{1}{5}$ to $\frac{1}{4}$ basket per acre, about October to November and reaped from February to March. It is said to prefer a heavy soil and is frequently grown on the silt of islands. In many places it is also sown before the end of the rains, about September, and reaped in December or January. In Sagaing District, it is grown on the black soils of the wheat tracts and it also sometimes follows "kauk-hnyin" paddy in inundated tracts or it is sown along the "kazins" (bunds) of paddy fields. In Sagaing District, and also in Shwebo it is frequently sown on paddy lands in seasons when the rainfall has been insufficient for the successful growth of paddy. Very little care is bestowed on the cultivation, the seed being scattered, harrowed in and no after-cultivation being given. In many districts it is scattered among the paddy before the latter is harvested, while the ground is still moist. When the paddy is removed, the Mât-pè has a chance to grow and may produce a fair crop. Harvesting is done partly by pulling and partly by cutting off with the "tazin" (sickle). Threshing is carried out by beating with sticks or by treading with bullocks, usually the former. Eight to 10 baskets per acre is a very fair crop.

Mât-pè is not available to any extent for export, the produce at present being generally ground and consumed in the form of cakes ("payàgyaw-môn"—fried pagoda bread). These cakes, though a common article of daily consumption, are specially eaten at pagoda festivals. They are made by kneading the meal with sessamum or groundnut oil and subsequently frying in oil. The seed is also frequently germinated and eaten when the radicle appears. The seeds are mucilaginous and are often boiled and eaten mixed with cooked rice.

VARIETY 2.—**Phaseolus Mungo, v. radiatus, Linn.**

Plants green throughout.

All *leaflets* broadly ovate-acute, the laterals being oblique; *bracteoles* about as long as the calyx.

Pods long, sharp-pointed, borne usually in twos or threes near the ends of the peduncles at right-angles to them and radiating horizontally, or but slightly drooping, drying to dark brown or black; length 2·5″ to 3″, breadth 0·13″ to 0·19.″

Seeds short cylindrical, retuse, small, 10 to 15 per pod, green, yellow, or black; *hilums* small but prominent; *testa* roughened by irregular wavy striae or ridges easily seen under magnification.

Sub-variety (*a*) :—*Seeds* dull green.

Size of seed :—

L. 0·1″ to 0·15″
B. 0·1″
T. 0·1″

Weight per 100=3·63 gms, or 780 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Pè-di-sein.	
Mônywa		
Pyapôn	Pè-nauk-sein.	
Magwè		
Nyaunglun (Yamèthin)		
Pakôkku		
Meiktila	Pè-nauk.	
Hanthawaddy ...		
Tharrawaddy ...		
Minbu		
Gyôgya-in (Yamèthin) ...		
Ywadan (Yamèthin) ...		
Bassein		
Magwè		
Banmauk (Katha) ...		
Mandalay		
Sagaing		
Lashio	Pè-di or Pè-ti.	
Sandoway		
Pegu		
Kamaing (Bhamo) ...		
Banmauk (Katha) ...		
Wuntho (Katha ...		
Mandalay		
Lashio	To-pi-si.	

Sub-variety (*b*) :—*Seeds* dull yellow to light brown.

Size of seed :—

L. 0·15″ to 0·18″
B. 0·1″—0·12″
T. 0·1″—0·12″

Weight per 100=2·33 gms, or 1,216 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Pè-di-wa.	
Sagaing		

Sub-variety (*c*): —*Seeds* dark brown to black. The irregular wavy striae or ridges on the testa, easily seen under magnification, serve to readily distinguish the seed of Pè-di-nêt from that of Mât-pè (Phaseolus Mungo proper), apart from the size.

Size of seed:—

L. 0·15″ to 0·2″
B. 0·1″—0·15″
T. 0·1″—0·15″

Weight per 100=2·5 gms., or 1,134 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Sagaing	Pè-di-nêt.	
Mandalay		
Kyauksè	Pè-nauk.	
Tazê (Mu River) ...		
Myingyan		
Pakôkku	Pè-nauk-nèt.	
Mônywa		

Notes.

The "Pè-di's" are sown largely on high lands and yás and sometimes on islands, from June to November, at the rate of ⅛ or ⅙ basket of seed per acre, and reaped from September to January. The method of cultivation is the same as that for Mât-pè. They are frequently scattered, about September or October, in paddy fields where there is sufficient moisture, before the paddy is reaped. After the paddy is cut, the Pè grows rapidly and produces a small crop of 3 or 4 baskets per acre. When grown alone, 6 or 8 baskets per acre is a fair outturn.

They are consumed in the same way as Mât-pè, being generally sprouted before being eaten. The boiled seeds are often mixed with, or eaten instead of cooked rice, and the young pods are occasionally eaten as a vegetable.

Very little, if any, export takes place from the country; but in some districts, there is a considerable excess of produce which is transported to other districts and sold at the rate of about Rs. 3 to 4 per basket.

E.—Phaseolus calcaratus, Roxb.

Erect to sub-erect or twining annuals with more or less grooved stems which are clothed with short, fine, spreading, deciduous, white hairs.

Leaflets ovate, sub-caudate, entire of faintly lobed (frequently the laterals alone are lobed); *petioles* often exceeding the length of the peduncle; *stipules* conspicuous, ovate-lanceolate, attached below the middle; *stipels* linear-lanceolate, sessile.

Peduncles medium-sized to long, slender, with 5 to 20 flowers borne in a long or short, conical and congested but not capitate raceme; *flowers* like those of P. Mungo but nearly twice as large; *bacteoles* linear-lanceolate, about twice the length of the calyx-cup; *calyx-cup* 0·125″ to 0·25″; *teeth* short, deltoid; *corolla* yellow, 0·75″ in diameter, much contorted and crumpled; *keel* long, falcate.

Pods sub-terete to sub-falcate and torulose, acute and glabrous, green, often with purple sutures, drying to brown, 2·5″ to 5″ in length and 0·16″ to 0·25″ in breadth.

Seeds 8 to 12 per pod, sub-cylindrical, rounded or sub-retuse at the ends, with prominent white hilums; they vary in colour from greenish-yellow to brown, purple or black, and are sometimes speckled.

Variety (*i*):—*Stems* short, stout, erect to sub-erect, seldom twining.

Race (*i*):—*Seeds* grey or brown, speckled with black.

Size of seed:—

L. 0·25″—0·35″
B. 0·18″—0·25″
T. 0·15″—0·22″

Weight per 100=11·71 gms., or 242 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Bhamo	Kachin-pè.	
Mômeik (Bhamo) ...	Palaung-taung-pè.	
Sandoway	Pè-taing-doung.	
Akyab	Pè-nauk soung.	
Chin Hills	Bi-li	A few seeds only found in a mixture called Bi-li.
Chin Hills	Be-tyel.	
Lashio	Pè-yin-anêt, or Toyin.	
Mungloi (Kachin Hills) ...	Ning-krung-shaprè ...	A few seeds only found in a mixture called Ning-krung-shaprè.

Race (*ii*):—*Seeds* chocolate-red mottled with black.

Size of Seed:—

L. 0·25″—0·32″
B. 0·16″—0·21″
T. 0·12″—0·17

Weight per 100=8·34 gms., or 340 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Chin Hills	Bè-pwè, Bu-hlule, Bè-tè.	
Henzada	Pè-yin.	

Variety (2) :—*Stems* slender, twining.

Race (*i*) :—*Seeds* pale yellow or greenish-yellow to deep-red or dark brown in colour ; very variable in size.

Size of seed:—

L. 0·22″—0·36″
B. 0·14″—0·24″
T. 0·12″—0·2″

Weight per 100=8·59 gms., or 330 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Lashio	Pè-yin-awa.	
Chin Hills	Bè-sang. Beir-tai. Bi-li	Mixed.
Bhamo	Kachin-pè ...	Mixed.
Mungloi (Kachin Hills) ...	Ning-krung-shaprè ...	
Bhamo	Hto-pyein-pè ...	
Banmauk (Katha) ...	Khawtoon-pè.	
Wuntho (Katha) ...		
Kyaukpyu	Pe-taing-doung-si.	
Amarapura	Pè-yin.	
Mandalay		
Sagaing		
Meiktila		
Choung-u (Sagaing) ...		
Nyaunglun (Yamèthin) ...		
Yamèthin		
Minbu		
Pegu		
Hanthawaddy ...		
Pakôkku		
Mônywa		
Magwè		
Prome		
Tharrawaddy ...		
Ma-ubin		
Mergui		
Thatôn		
Thayêtmyo		
Shwebo		
Myingyan		

Race (ii):—*Seeds* jet black.

Size of seed:—

L. 0·22″—9·32″
B. 0·15″—0·22″
T. 0·12″—0·19″

Weight per 100=7·77 gms., or 365 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Chin Hills	Bi-nark.	

Notes.

The principal race of P. calcaratus is Pè-yin (Variety 2, Race i). This pulse is cultivated throughout the plains and also in many places in the hills. The seeds vary very considerably in size and colour; the size largely according to local conditions, and the colour more largely according to the age of the seed. Fresh seed is generally pale or greenish-yellow in colour, but it frequently turns brown on keeping, even before it loses its power of germination. The seeds of the other races appear to be more permanent in colour. No difference was observed in the pods of the different races.

From the distribution lists it will be seen that this bean is very extensively cultivated and is grown at all elevations, from the lowest to the highest in Burma. It is chiefly sown as a cold weather crop in October or November and reaped in January or February. Sowing is done broadcast at the rate of about 4 *pyis* (¼ basket) per acre. It is largely cultivated on the silt of islands and on the river banks, where it gives a good outturn, but it is also cultivated away from the rivers. In the hilly districts, such as the Kachin Hills, it is sown towards the end of the rains and reaped about January; but it is also sown in *taungyas*, together with paddy, early in the rains. It is harvested and threshed in the ordinary way and is said to yield about 10 baskets per acre.

It is largely consumed by natives of India. Its uses among Burmans are similar to those of P. mungo. It is often boiled and eaten with or instead of rice. The straw (Pè-yin-yo) is considered excellent food for cattle and ponies.

The seed, which sells at the rate of about Rs. 3 per basket, is available for export in many districts, in small quantities. In those districts where it is more extensively cultivated, the crop is bought by brokers and shipped direct to Rangoon, whence it is distributed to the consuming areas. Rangoon being the collecting centre for the produce, it is frequently cheaper there than in up-country stations although the latter may be nearer the centre of production. A good deal of surplus produce is purchased by the Commissariat Department of Burma under the name of "Lobia," a name which is more generally applied in India to Vigna Catiang.

Vigna Catiang, Endl.

Asparagus Bean, Cherry Bean, Cow Pea, Chowlee, Tow Cok.

Annual sub-erect or twining herbs with membranous, glabrous trifoliolate, stipulate leaves.

Stems sulcate, smooth.

Leaflets somewhat fleshy, ovate-oblong to ovate-lanceolate or rhomboidal ; *base* sub-cordate to sub-deltoid ; *apex* sharply or bluntly acute ; *margins* even, sinuous, or sometime sub-lobed ; *lateral leaflets* oblique, the outer curvature sometimes inclined to be lobed ; *petiole* stout, thickened at the base, deflexed, beyond the insertion of the laterals, broadly or shallowly grooved so as to form ridges ; *petiolules* stout ; *stipules* large, ovate-lanceolate, attached above the base ; *stipels* short, thick, oval to lanceolate.

Peduncles stout, grooved, usually long (often exceeding the length of the leaf) ; *racemes* bearing few flowers which are crowded near the ends of the peduncles on thickened tumid nodes ; *pedicels* very short ; *calyx* somewhat gibbously campanulate, with long or short triangular teeth of which the two upper (dorsal), which are often connate to near their apices, are the longest ; *calyx-tube* transversely rugulose ; *corolla* much exerted ; *keel* truncate ; *stamens* diadelphous ; *staminal tube* arched not elbowed ; *anthers* uniform; *ovary* sessile, many ovuled ; *style* long, filiform, bearded on the inner curve immediately below the oblique stigma.

Pod linear, often very long, sub-terete, many-seeded, septate to sub-septate.

Seeds sub-rectangular to reniform, more or less dorsally keeled smooth or wrinkled, white, brown, red, black or speckled ; *hilum* comparatively small, situated above the middle.

The flowers of all the Vignas examined open in the morning and close before noon. In closing, the standard and wings completely fold back almost into their original positions.

Key to the vareities and races of Vigna Catiang.

Variety (1):—Vigna Catiang, var : typica :— Stems robust, short seldom twining.

Sub-variety (*a*):—Pods thick, valves stiff, slightly constricted between the seeds.

Race (*i*):—Seeds sub-rectangular, pinkish-white to dark-red.

Race (*ii*):—Seeds sub-reniform, jet black.

Race (*iii*):—Seeds reniform, red to black or speckled.

Sub-variety (*b*):—Pods more delicate, valves parchment-like, not constricted between the seeds.

Race (*i*):—Seeds retuse, light-red.

Race (*ii*).—Seeds reniform, white streaked with brown or black on each side of hilum.

Race (*iii*):—Seeds reniform, piebald (black and white).

Variety (2):—Vigna Catiang, var : sinensis :— Stems free-branching, twining or trailing.

Sub-variety (*a*).—Pods medium in length, valves thick, soft, slightly constricted between the seeds.

Seeds sub-rectangular, greyish-white marbled with brown to red marbled with black.

Sub-variety (*b*):—Pods long, narrow, valves thin and parchment-like.

Seeds small, reniform, yellow to deep-red or speckled.

Sub-variety (*c*):—Pods very long, valves thin, soft, much constricted between the distant seeds.

Seed reniform, flattened, red.

Variety 1.—Vigna Catiang, var. typica.

Plant.—*Stems* robust, short, thick, seldom twining.

Sub-variety (*a*) :—*Pods* 1 to 3 per peduncle, slightly constricted laterally between the seeds, smooth, septate, thick; valves stiff and brittle when dry, only slightly curling back on dehiscence. Length of pod 3·5″ to 8″; circumference 0·5″ to 1″; number of seeds 8 to 18.

Race (*i*) :—*Seeds* almost rectangular, somewhat keeled dorsally, varying from pinkish white to dark red in colour.

Size of seed :—

L. 0·25″—0·33″

B. 0·21″—0·25″

T. 0·15″—0·2″

Weight per 100 = 11·72 gms., or 240 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Pyapôn	Pè-lôn.	
Henzada		
Bassein		
Meiktila		
Mônywa		
Magwè		
Minbu		
Yamèthin		
Kyauksè		
Mandalay	Pè-lôn. Pè-leik-kauk.	
Gyô-gya-in (Yamèthin) ...	Pè-lêt-kauk.	
Amarapura	Pè-lôn. Pè-sa-u.	
Toungoo	Pè-lôn. Pè-argyan (Pe-akyan ?) Da-la-pe (Ta-la-pe ?).	Mixture.
Myinmu	Pè-lôn.	
Ywadan (Yamèthin) ...		
Tharrawaddy		
Hanthawaddy		
Pakôkku		
Pegu		
Mônywa	Nadaw-pè.	

Race (*ii*) :—*Seeds* somewhat more kidney-shaped, jet black.

Size of seed :—

L. 0·3″—0·35″

B. 0·25″—0·28″

T. 0·15″—0·2″

Weight per 100=14·175 gms., or 200 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Pegu	Pè-yin.	
Gyôgya-in (Yamèthin) ...	Pè-lôn. Pè-lêt-kauk. Pè-nattaw.	
Myingyan	Pè-lôn-san.	
Mandalay and Amarapura ...	Pè-dauk-thi. Pè-shwe-wa. Pè-myin-sa-yaung.	
Akyab	Wagaung-pè. Pè-mè. Pè-mi-go.	
Sandoway	Pè-byu-show. Pè-myi-sho.	
Shwepyi (Singu)	Pè-lêt-nyo-anêt.	
Hanthawaddy	Pè-daung-lât-anêt.	
Mômeik (Katha)	Tazaungmôn-pè.	
Chin Hills	Bui-loi. Som-pi-nark. Verk-yeil.	
Magwè	Hin-sa-pè. Pè-gaung-baung ...	Mixture.

Race (*iii*) :—*Seeds* reniform, red speckled with black to black.

Size of seed :—

L. 0·3″—0·4″

B. 0·24″—0·35″

T. 0·15″—0·18″

Weight per 100=15·08 gms., or 188 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Wuntho (Katha)	Khawtoon-pè ...	Contains quantities of the seeds of *Phaseolus calcaratus.*

Sub-variety (*b*) :—*Pods* smooth, delicate; valves parchment-like when dry, not constricted between the seeds.

Race (*i*) :—*Seeds* almost rectangular, light red.

Stardard of flower marked in the centre with three yellow streaks.

Size of seed :—

L. 0·3″—0·35″
B. 0 26″—0·3″
T. 0·15″—0·18″

Weight per 100=14·92 gms., or 190 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Hanthawaddy	Pè-doung-to ...	Collected in Hanthawaddy only.

Race (*ii*) :—*Seeds* kidney-shaped, white, with a broad yellowish-brown to black streak on each side of the hilum.

Size of seed :—

L. 0·31″—0·4″
B. 0·22″—0·27″
T. 0·15″—0·21″

Weight per 100=18·41 gms., or 154 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Hanthawaddy ... ... Meiktila	Pè-nga-shan.	
Lashio (Northern Shan States) ...	Pè-daung-shè-apyu.	
South Hsenwi State (Northern Shan States).	San-to-haí.	
Minbu	Nattaw-pè.	

Race (iii) :—***Seeds*** **reniform, piebald (black and white).**

Size of seed:—

L. 0·38″—0·47″

B. 0·27″—0·3″

T. 0·16″—0·23″

Weight per 100=22·32 gms., or 127 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Lashio	Pè-doung-shè ...	Mixed with Pè-doung-shè-a-ni and several other kinds of seed, including Dolichos, from the same place.

VARIETY 2.—**Vigna Catiang, var: Sinensis.**

(Syn.—*Vigna Sinensis.*)

Stems free-branching, twining or trailing.

Sub-variety (*a*) :—*Pods* dark brown, slightly constricted between the seeds, smooth, septate ; valves thick and soft, but brittle when dry, only slightly curling back on dehiscence. Length of pod 3·5″ to 8″, breadth 0·4″ to 0·6″ ; number of seeds 8 to 18.

Seeds are almost rectangular, somewhat keeled dorsally, and vary in colour from greyish white marbled with brown to blood-red marbled with black.

Size of seed:—

L. 0·25″—0·3″

B. 0·22″—0·3″

T. 0·15″—0·22″

Weight per 100=12·32 gms., or 230 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Magwe	Pè-ngât-kya. Pè-gaung-baung ...	Mixture.
Mônywa	Pè-gaung-baung.	
Nyaung-lun (Yamèthin) ...	Pè-kyaung-ma.	
Mônywa	Pè-tît-ti-du ...	Lit. "Plover-pea."
Yamèthin	Pè-kyaung.	
Lashio	Pè-daung-shè-a-ni.	

Sub-variety (*b*) :—Pods long, narrow, with thin and parchment-like valves each of which, on dehiscing, curls upon itself closely. Length of pod 5″ to 8″, breadth 0·25 to 0·3″ ; number of seeds 8 to 18.

Seeds small, reniform, yellow to deep red or more usually speckled.

Size of seed:—

L. 0·25″—0·3″

B. 0·15″—0·18″

T. 0·13″—0·15″

Weight per 100—8·34 gms., or 340 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Chaung-u (Sagaing)	Ta-lá-pè ...	Found at Chaung-u only.

Sub-variety (*c*) :—*Pods* often very long; valves thin and soft, much constricted between the seeds which are usually far apart. Length of pod from 8″ to 18″ or even longer, breadth 0·25″ to 0·5″ ; number of seeds usually 12 to 22 per pod.

Seeds reniform, flattened, red.

Size of seed:—

L. 0·35″—0·45″

B. 0·2″—0·27″

T. 0·13″—0·17″

Weight per 100=13·125 gms., or 216 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Pè-dauk.	
Shwebo	Pè-dauk-she.	
Kyauksè		
Katha	Tine-doung-pè.	
Hanthawaddy		
Mômeik (Bhamo)	Tine-doung-pè. Ta-lá-pè-tine-doung.	
Banmauk (Katha)	Tazaungmôn-pè.	
Nyaunglun Ywadan Gôygya-in (Yamèthin) ...	Pè-nattaw.	
Akyab	Pè-paw-ani. Pè-wet-taung. Pè-shauk-kan. Thôn-la-pè. Tawthalin-pè. Thôn-daung-gyaw-pè	litt: "three-cubit-long-pea."
Hsipaw (Northern Shan States)	Pè-yin. Pè-ni. To-pai.	
Moulmein	Pè-dauk-shè.	
Amherst		

Notes.

Vigna Catiang is widely distributed and, in some districts, extensively cultivated both as a garden and a field crop. It is grown on islands, river banks, ordinary dry lands and also in *yás*. It is said to be valuable in that it is the first crop which can be taken off a new deposit of clay silt. When grown on such a deposit no cultivation is given but the seeds are dibbled two or three together in holes, made by a stick, about a yard apart.

The usual time of sowing is about September or October ; but it is also sown about June—or at any time during the rains—especially on *yá* lands and dry up-lands. In ordinary cultivation and on islands the seed is frequently dibbled in, but on *yás* and up-land sandy soils, it is more frequently broadcasted at the rate of about one- fourth basket per acre and afterwards thinned by means of the "*htun*" (Burmese harrow). One hoeing is often given during the growth of the plants and sometimes the soil is pulled up round the roots. It is very frequently sown

mixed with maize, sessamum, and sometimes with other peas and beans.

Vigna Catiang, var. typica is the variety most generally cultivated as a field crop under the name *Pè-lôn*, whilst the variety *sinensis*, which is generally known as *Pè-dauk-shè*, *Pè-dauk-thi*, or *Tine-daung-pè*, is usually sown during the rains, in gardens where it is allowed to trail over fences, stakes, etc., and is made to take care of itself, not being hoed, manured or otherwise attended to. The extremely long pods of this variety are most generally used as a green vegetable. Some of them are said to attain the length of three cubits (*thôn-daung-gyaw-pè*—Akyab).

The pods are plucked about March, dried in the sun for a few days and the seeds beaten out with sticks. The yield varies from 6 to 10 baskets per acre, and the price is usually about Rs. 1-8 to Rs. 2 per basket.

The young leaves and shoots are boiled and eaten as well as the tender pods—all being favourite adjuncts of "*hein-cho.*" The dry seeds are parch. d or boiled and eaten like peas, and also used in place of nuts for the making of sweetmeats. When boiled they are mixed with *kaukhnyin* (glutinous rice) which is further flavoured with til seed, salt, turmeric, and sessamum oil and eaten as a delicacy between meals.

These beans are available in a few places only for export, but, as their cultivation is easy, a demand for the seed would, in many places, cause a rapid extension of cultivation.

Pachyrhizus angulatus, Rich.

Chinese Potato, Yam Bean.

Extensively-twining, much-branched perennial clothed with a soft, dense, brown pubescence which is deciduous from the older parts.

Leaves trifoliolate, with stipellate, lobed leaflets; *leaflets* large, membranous, as broad as long or broader, margins toothed or slightly lobed: apex acute, base deltoid: laterals very oblique; *petioles* slender, sulcate

Racemes long, few-flowered, usually borne beyond the middle of the peduncle (6″ to 12″); *nodes* somewhat tumid: *flowers* single or in fascicles of 2 to 4 on short pedicels, showy, lilac-blue in colour; *calyx* as long as the pedicel, four-cleft (owing to the two upper teeth being connate) teeth long, equal, acute, yellowish brown with adpressed brown hairs; *bracteoles* small, lanceolate, caducous; *corolla* much exserted; *petals* equal; *standard* but slightly reflexed, sub-orbicular; *wings* narrow oblong, long-spurred; *keel-petals* similar to the wings in shape, spur very long; *stamens* diadelphous; *anthers* uniform, dorsifixed, filaments cylindrical; *gymnœcium* hairy throughout; *ovary* sub-sessile, many-ovuled; *style* long, circinnate, bearded especially down the inner side; *stigma* capitate.

Pods 6″ to 9″ long, straight, flattened, strap-shaped, shortly rostrate; *valves* stiff, septate to sub-septate, laterally depressed between the seeds, brown-hairy or glabrescent.

Seeds rectangular, flattened, frequently somewhat broader than long, greenish to dark brown; about 8 per pod.

Roots usually solitary, swollen, napiform, white and succulent, covered with a thin yellowish-white fibrous skin which is very easily peeled off.

Size of seed:—
L. 0·3″ to 0·35″
B. 0·29″—0·35″
T. 0·14″—0·2″
Weight per 100=19·2 gms., or 148 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Amarapura	Pè-sein-sa-u, Sein-sa-u or Asein-sa-u.	Pè-sein-sa, Sein-sa and Asein-sa are the names given to the plant; with suffix-*u* the name signifies the root of the plant.
Mandalay		
Sagaing		
Mômeik (Katha) ...		
Pegu		
Pakôkku ...		
Myingyan		
Upper Chindwin ...		
Lower Chindwin ...		
Prome		
Tavoy		
Mergui		
South Hsenwi State ...		
Lashio (Northern Shan States).		
Myaungmya		
Arakan		
Akyab	Mrauk-u, or Mah-pra.	

Notes.

This bean is cultivated only for its tuberous roots and not for its seeds and pods which are said to be noxious and intoxicating. It is cultivated both in gardens and fields, but generally as a field crop on silts and the light soils of islands and river banks. The ground is carefully harrowed and a fine tilth obtained. The seed is sown thickly in small furrows, made by the seven-toothed harrow, about 10 inches apart. This takes place about September—October and the amount of seed required is 2½ baskets per acre. The rows being very close together, when the tubers form, they are crowded beneath the crop. Two or three weedings are generally given. The plants on the fields are seldom staked but allowed to creep or trail over the surface of the ground. In garden cultivation, the seeds are dibbled in an inch apart in rows about 3″ from one another on beds which are about 3 feet wide. The crop occupies the ground for about 5 or 6 months, being harvested about February—March. The tubers are dug up by the "*ta-ywin*" (Burmese spade) and are said to easily yield 2,000 viss per acre. In garden cultivation as much as 8,000 viss per acre is said to be obtained (1 viss=3·65 lbs). The mature crop is sold to buyers who harvest the roots themselves, or immediately after being harvested by the cultivator. The wholesale price on the field varies from Rs. 3-8 to Rs. 7-8 per 100 viss.

The white turnip-like fleshy roots are frequently eaten raw (the name *Asein-sa* signifies "edible whilst raw") but sometimes after being sliced and cooked. The roots have a pleasant sweetish taste.

Key to species of Dolichos.

A.—*D. Lablab.*	B.—*D. Biflorus.*
1. Extensive twiners.	1. Low-growing annual herb.
2. Calyx glabrescent, teeth short, triangular.	2. Calyx downy, teeth lanceolate, setaceous, exceeding length of tube.
3. Style widening upwards, bearded down inner edge.	3. Style filiform, penicillate round stigma, not bearded on inner edge.
4. Pods not downy, usually indehiscent.	4. Pods small, downy, dehiscent.
5. Seeds large, not lenticular.	5. Seeds small, lenticular or flattened.

A.—Dolichos Lablab, Linn.

Indian Bean, Lablab Bean.

Extensively twining annual or perennial herbs or undershrubs with more or less scabrid woody stems and branches.

Leaves trifoliolate ; *leaflets* entire, broadly ovate to ovate-oblate, acute or acuminate, mucronate, deltoid to sub-deltoid, *laterals* oblique ; *venation* distinct, often prominent ; *laminæ* rugose between the veins, sub-glabrous or softly woolly-hairy, margins entire, even, or sometimes wavy ; *petioles* usually slender, laterally compressed, narrowly grooved above, deflexed, base of petiole thickened ; *petiolules* thick cylindrical; *stipules* and *stipels* triangular to lanceolate, basifixed, deciduous.

Peduncles stout axillary, solitary, long (up to 18″) or short (½″) ; *pedicels* short, fascicled towards the apex or alternate on the peduncle, arising from prominent tubercular thickenings ; *flowers* few (3 to 5), white fading to yellow, or pink-purple fading to blue ; *calyx* obliquely campanulate, teeth short-triangular (deltoid), two upper connate, the calyx-cup being partially enclosed by two small lateral and opposite *bracteoles* which are scarious and caducous ; *standard* sub-orbicular or oblate, emarginate, much reflexed and often folding back upon itself, with two raised calli projecting on the disc below the anterior middle and enclosing the bases of the wings ; *wings* obliquely obovate ; *keel* narrow, rostrate, petals united to near the long spurs, elbowed (not arched), exserted beyond the wings, *stamens* diadelphous, *anthers* uniform, basifixed ; *ovary* flattened, slender at the base but not stalked; *style* persistent, narrow, flattened, widening upwards, hairy on the inside below the terminal and usually capitate stigma.

Pods 2″ to 6″ long and 0·5″ to 2″ wide, sub-erect to pendulous, flattened, oblong or sub-cylindrical, cuneate at the base, acute or retuse and usually recurved at the distal end which is also rostrate from the remains of the persistent style ; *valves* tough or chartaceous, sutures rough or rugose.

Seeds 3 to 6 per pod with axes at right-angles to the axis of the pod, oblique, or parallel to it, varying greatly in colour ; *hilum* large, prominent, white.

Key to the varieties and races of Dolichos Lablab.

Variety (1) :—Pods short, truncate, seed axis at right-angles to axis of pod.

Sub-variety (*a*) :—Pods flat, septate, valve smooth.

Race (*i*) : —Seeds white, flowers small, white.

Sub-race α :—Seeds flattened laterally.

Sub-race β :—Seed small, almost spherical.

Race (*ii*) :—Seeds white marked with brown near hilum, flowers pink to purple.

Race (*iii*) :—Seeds red to black, flowers pink to purple.

Sub-variety (*b*) :—Pods narrow, indented between seeds on sutures, very abruptly truncate, valves much wrinkled or rugose.

Race (*i*) :—(Only one race) seeds red to black.

Sub-race α :—Flowers white, peduncles short.

Sub-race β :—Flowers pink to purple, peduncles long.

Sub-race γ .—Flowers pink to purple, peduncles very short.

Sub-variety (*c*) :—Pods very broad, flat, truncate.

Race (*i*) :—(Only one race) seeds long, flattened, red to black.

Sub-race α :—Flowers purple, pods green.

Sub-race β :—Flowers white, pods green.

Sub-race γ :—Flowers purple, pods extremely broad and purple.

Variety (2) :—Pods long, narrow, pointed, seed-axis at right angles to axis of pod or slightly oblique.

Race (*i*) :—Seeds red to black.

Sub-race α :—Flowers white.

Sub-race β :—Flowers purple.

Race (*ii*) :—Seeds white marked with brown near hilum, flowers white.

Variety (3) :—Pods long, slender, pointed, seed axis parallel to axis of pod.

Sub-variety (*a*) :—Pods smooth though curved.

Race (*i*) :—Seeds red to black.

Sub-race α :—Flowers white.

Sub-race β :—Flowers pink to purple.

Race (*ii*) :—Seeds white marked with brown near hilum, flowers mauve.

Sub-variety (*b*) :—Pods rugose, narrow and deeply indented between seeds.

Race (*i*) :—Seeds red, flowers white.

Race (*ii*) :—Seeds white, marked with brown near hilum, flowers purple.

A.—Dolichos Lablab, Linn.

Variety (1) :—(D. Lablab v. lignosus, Prain).

Pods short, squat, abruptly truncate at the distal end.

Seeds with axes at right-angles to the axis of the pod.

Sub-variety (*a*) :—

Pods flat, distinctly septate; valves, when dry, smooth or only slightly wrinkled; 1·5″ to 2·75″ in length and 0·5″ to 1″ in breadth.

Seeds 3 to 5 per pod.

Race (*i*) :—

Seeds pure white.

Flowers generally small, white throughout, with the back of the standard pale green.

Sub-race a :—*Seeds* large, flattened laterally.

Size of seed: —

L. 0·40″ to 0·62″
B. 0·33″ to 0·45″
T. 0·28″ to 0·33″

Weight per 100=48·8 gms., or 58 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Amarapura	} Pè-gyi.	
Mandalay		
Shwèpyi		
Singu		
Sagaing		
Chaung-u		
Pegu		
Henzada		
Banmauk		
Ywadán		
Sandoway		
Hanthawaddy		
Tharrawaddy ...		
Minbu		
Magwè		
Pakôkku		
Mônywa		
Bassein		
Belin (Kyauksè) ...		
Mandalay	Pè-pazun-byu.	
Mônywa	Pè-maung-ma-kaw ...	Mixed.

Sub-race β :—

Seeds small, much more spherical than in common Pè-gyi (Sub-race *a*).

Pods also smaller than in common Pè-gyi.

Size of seed:—

L. 0·30″ to 0·40″
B. 0·25″—0·30″
T. 0·20″—0·25″

Weight per 100=23·3 gms., or 122 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mônywa	Pè-gyi-sa-u ...	(Sa-u = Sparrow's egg.)
Choung-u	Pè-gyi-sa-u Pè-sa-u, or Kôn-pè	This form of Pè-gyi is said to be evolved by cultivation on high lands under dry conditions and is believed by cultivators to become Pè-gyi proper when grown in low land under more moist conditions. (Kôn = high ground.)

Race (ii) :—

Seeds white, with persistent dark-brown markings at each end of hilum,—that around the micropyle being small and semi-circular, while that over the strophiole at the distal end is large, distinct, and clavate ; the seeds are also often speckled with brown, but this speckling is not constant.

Flowers few, deep pink to purple.

Size of seed :—

L. 0·3″ to 0·45″
B. 0·25″—0·35″
T. 0·2″—0·3″

Weight per 100 = 25·77 gms., or 110 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Ywadan ...	Pè-gyi. Pè-maung-ma-kaw. Pè-lêt-ma.	
Meiktila	Pè-maung-ma-kaw.	
Mônywa	Do. ...	A few seeds mixed with others.
Bhamo	Pè-bya-gyi-apyu.	
Pakôkku ...	Pè-byu-galè. Ngazu-pè.	

Race (iii) :—

Seeds deep red to black, plain or speckled.

Flowers like those of Race (ii) ; inflorescence a long stout raceme on which the flowers are borne above the middle in fascicles of 3 or 4.

Size of seed :—

L. 0·35″ to 0·65″
B. 0·25″—0·35″
T. 0·20″—3″

Weight per 100=34·57 gms., or 82 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mônywa	Pè-maung-ma-kaw.	
Myingyan	Pè-maung-ma-kaw.	
Nyaung-u (Minbu) ..	Wèt-thè-hkauk.	
Chin Hills	Ngun-bè-pi ...	In Ngun-bè-pi the seeds are larger and more tumid than others of this race; hence the pods are somewhat larger, probably owing to more favourable conditions of growth.

Sub-variety (b) :—

Pods generally narrow, somewhat constricted between the seeds and more or less deeply indented between them on the sutures, broadening at the distal end where it is very abruptly truncate (Wet-swè=Boar's tusk) ; valves, when dry, much wrinkled or rugose. Pod from 1″ to 3″ in length and 0·5″ to 0·8″ in breadth. Seeds 3 to 5 per pod.

Race (i) :—*Seeds* medium-sized, red to black in colour.

Size of seed :—

L. 0·4″ to 0·55″
B. 0·25″—0·4″
T. 0·2″—0·3″

Weight per 100=39·64 gms., or 78 seeds per oz.

There is only one race in this sub-variety.

Sub-race a :—

Flowers pure white, peduncles not long; green pods full, tumid and firm.

Distribution.

Locality.	Local name.	Remarks.
Mômeik	Nwè-pè ...	This is sometimes called Nwè-pè-akyi, and also Nwè-pè-angè.
Bhamo ...	Wêt-swè. Pè-lêt-to.	

Sub-race β :—

Flowers pink to purple, peduncles long; green pods like those of Sub-race *α*.

Distribution.

Locality.	Local name.	Remarks.
Kamaing	Pè-lêt-ma ...	Mixture.
Lashio	Pè-lêt-ma ... To-tât ...	Mixture.
Chin Hills	Har-naun.	
Mandalay	Pè-thalè-do.	

Sub-race γ :—

Flowers coloured but paler than those of Sub-race *β*; peduncles very short, often so much so that the fascicles of flowers appear to be sessile.

Distribution.

Locality.	Local name.	Remarks.
Katha	Nwè-pè ...	In Nwè-pè (Katha) the seeds are larger and more tumid than others of this race, hence the pods are somewhat larger.

Sub-variety (*c*) :—

Pods very much longer, broader and flatter than those of Sub-varieties (*a*) and (*b*), but still very truncate; from 5″ to 6″ in length and 1·5″ to 2″ in breadth; seeds extending to only about half the breadth of the pod.

This sub-variety is a perennial and is often grown as such in many places. Its pods are by far the largest and softest of any of this species.

Race (*i*) :—*Seeds* long and flattened (like those of Pè-gyi in shape) 3 to 5 per pod ; colour dark red to brown or black, plain or speckled.

Size of seed :—

L. 0·4″—0·6″
B. 0·3″—0·45″
T. 0·2″—0·3″

Weight per 100=41·48 gms. or 68 seeds per oz.

There is only one race in this sub-variety.

Sub-race a :—

Flowers purple ; inflorescence, usually, a long raceme (sometimes short) bearing the fascicles of flowers over the greater part of the peduncle ; pods very broad, green drying to brown ; seeds generally black, or very dark speckled.

Distribution.

Locality.	Local name.	Remarks.
Amarapura	Pè-napya.	
Chaung-u		
Sagaing		
Sagaing	Pè-pazun.	
Ywadàn	Pè-bya.	
Bhamo	Pè-bya-gyi.	

Sub-race β :—

Flowers white ; pods like those of Sub-race *a*, seeds generally red.

Distribution.

Locality.	Local name.	Remarks.
Belin (Kyauksè) ...	Pè-napya.	

Sub-race γ :—

Plants, except laminæ of leaves, deep reddish-purple ; inflorescence a long or short raceme in which the fascicles of deep purple flowers are crowded together near the ends ; pods, usually, short and proportionately broader than those of Sub-races *a* and *β* deep reddish-purple fading to cobalt blue and drying to brown.

Seeds sometimes sub-spherical.

Distribution.

Locality.	Local name.	Remarks
Mandalay	Pè-kadipa.	
Magwe		

Variety (2) :—

Pods long, narrower than in Variety 1, and pointed at the distal end ; length 2″ to 6″, breadth 0·5″ to 0·75″.

Seeds with axes at right angles to the axis of the pod or slightly oblique.

There are no sub-varieties in this variety and only two races.

Race (*i*) :—*Seeds* 3 to 5 per pod, deep red to black.

Size of seed :—

L. 0·33″—0·55″

B. 0·25″—0·4″

T. 0·2″—0·3″

Weight per 100 = 34·55 gms, or 82 seeds per oz.

Sub-race a :—

Flowers white ; young pods white ; seeds red.

Distribution.

Locality.	Local name.	Remarks.
Ywahine-ayât ...	Nwè-pè.	
Shwè-pyi		
Mandalay ...	Pè-pazun-byu.	
	Pè-hla-tha.	
	Pè-seik-cho-apyu.	
	Bo-sa-pè.	
Magwè	Pè-pazun.	

Sub-race β :—

Flowers pink to purple ; young pods generally greenish purple seeds speckled to black.

Distribution.

Locality.	Local name.	Remarks.
Yankin-daung ...	Pè-pazun-ni	The ventral suture of the pod is sometimes cleft, forming two ridges.
Madaya		
Magwè ...	Pè-bya. Pè-bya-gyi.	
Myingyan	Pè-thi-ben.	
Ywadan	Pè-seik-cho.	
Chaung-u	Pè-seik-cho-anet.	

Race (*ii*) :—

Seeds white with persistent dark-brown markings at each end of the hilum,—that around the micropyle being small and semi-circular, while that over the strophiole at the distal end is large, distinct and clavate ; the seeds are often speckled with brown, but this speckling is not constant.

Flowers white.

Size of seed :—

L. 0·35″—0·4″
B. 0·3″—0·35″
T. 0·2″—0·25″

Weight per 100 = 29·5 gms., or 96 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay ...	Pè-napya. Pè-seik-cho-apyu.	

Variety (3) .—(D.Lablab, proper, Prain).

Pods long, slender, pointed ; length from 3″ to 6″ breadth up to 0·5″. *Seeds* 3 to 5 per pod, with axes parallel to the axis of the pod.

Sub-variety (*a*) :—

Pods more or less smooth though curved.

Race (*i*) :—Seeds red to black.

Size of seed :—

L. 0·3″—0·6″
B. 0·25″—0·4″
T. 0·2″—0·3″

Weight per 100=35·12 gms., or 80 seeds per oz.

Sub-race α :—

Flowers pure white.

Distribution.

Locality.	Local name.	Remarks.
Lashio	Pè-lèt-ma, To-tat ...	Seeds generally deep red.
Chin Hills	By-lip	Seeds generally black.

Sub-race β.

Flowers pink to purple.

Distribution.

Locality	Local name	Remarks.
Belin (Kyauksè) ...	Nwè-pè.	
Bhamo	Pèbya-gyi, Wa-kyeik-lein, Wa-kyeik-lein pè-ni.	
Kamaing	Pè-wa-kyeik, Pè-lèt-ma	Mixed.
Mônywa	Pè-pazun.	
Chaung-u		
Pakôkku		
Amarapura		
Katha	Wèt-swè.	

Race (*ii*) :—

Seeds white with persistent dark brown markings at each end of the hilum,—that around the micropyle being small and semi-circular, while that over the strophiole at the distal end is large, distinct, and clavate; the seeds are also often speckled with brown, but this speckling is not constant.

Flowers mauve.

Size of seed:—

L. 0·4″—0·6″
B. 0·3″—0·4″
T. 0·25″—0·3″

Weight per 100=47·84 gms., or 59 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
South Hsenwi State ...	To-pong.	
Chin Hills	Bè-pi.	

Sub-variety (*b*) :—

Pods similar to those of Sub-variety (*a*), but generally narrower and deeply intented between the seeds on the sutures; valves very rough and wrinkled or rugose (*Seik-cho*=Goat's horn).

Race (*i*) :—

Seeds red; flowers white.

Size of seed:—

L. 0·3″—0·4″
B. 0·25″—0·3″
T. 0·2″—0·25″

Weight per 100=21·09 gms., or 134 seeds per oz.

Distribution

Locality.	Local name.	Remarks.
Chaung-u	Pè-seik-cho-ani.	

Race (*ii*) :—

Seeds white with persistent dark brown markings at each end of the hilum,— that around the micropyle being small and semi-circular, while that over the strophiole at the distal end is large, distinct, and clavate; the seeds are also often speckled with brown, but this speckling is not constant.

Flowers purple.

Size of seed:—

L. 0·25″—0·4″
B. 0·25″—0·3″
T. 0·25″—0·3″

Weight per 100=26·04 gms., or 108 seed per oz.

Distribution.

Locality.	Local name.	Remarks.
Magwè	Pè-maung-ma-kaw. ...	The sample received under this name included several varieties of Dolichos and Vigna.
Meiktila	Pè-nan.	

Notes.

It may be noticed that, in our classification, *D. Lablab, v: lignosus* has been placed first. The reason for this arrangement is because this variety is by far the most important and most extensively cultivated Dolichos in the province.

With the exception of "*Pè-gyi*" [Var: 1, Sub-var: (*a*), Race i, Sub-race *a*] and its nearest allies "*Pè-gyi-sa-u*" and "*Pè-maung-ma-kaw*," the races of Dolichos Lablab are seldom cultivated to any great extent as field crops, though they are widely distributed and highly esteemed as garden crops, both in the hills and plains. The chief centres of field cultivation are Sagaing and Mandalay districts, where it is grown principally on the sandy stretches—islands and banks—of the Irrawaddy along which it extends down into Myingyan, Pakôkku and Lower Chindwin Districts.

Pè-gyi is sometimes called the "Rangoon White Bean" which term is also applied to *Pè-byu-galè* the small white Race of *Phaseolus lunatus*.

Dolichos is seldom grown on any but light sandy soils, though it will succeed on most soils found in Burma. The method of cultivation along the Irrawaddy is practically the same as that for all island crops. During a temporary fall in the water of the river, which generally occurs about August, the lands are ploughed and harrowed so that water may penetrate freely into the soil. When the floods permanently recede, about September-October, the land is again cultivated until a fine tilth is obtained. This second cultivation is most frequently carried out with the "*htūn*" (harrow) only, but, if a previous ploughing has not been possible, the "*htè*" (plough) is also used. The seed may be sown broadcast at the rate of about $\frac{3}{16}$ to $\frac{1}{4}$ basket per acre (one basket=9 gallons) or it is more generally sown in rows after the "*htūn*" with a distance of about $1\frac{1}{2}$ to 2 feet between the rows. Being a more valuable crop and more difficult to grow than *Pè-gya* or *Pè-byu-galè* (Phaseolus lunatus)—the other principal field pulses—greater care is bestowed on its cultivation. It is usually hoed two or three times during growth and the crop is reaped by hand plucking the pods about March or April. Threshing is done by beating with a stick or sometimes by treading with bullocks. The yield is about 10 to 15 baskets per acre. The price of the main crop, about harvest time, is approximately Rs. 2-8 per basket.

In passing through a field of D. Lablab, one notices a remarkable heavy, disagreeable, musty, bug-like odour arising from the plants. It

is well known to the cultivator and is most pronounced in a field c common *Pè-gyi*.

Dolichos Lablab is also found frequently growing on *Yá* lands o the plains as a cold weather crop, but on the hills it is sown on *taungyá* during March or April, usually near to some post, tree, or shrub whic forms a support for the twining plant. On these *Yás* it is allowed t remain and grow as a perennial.

The many races of Dolichos Lablab which are grown as garde crops are not sown at any particular season but at any time throughou the year, when conditions are favourable. They are usually sown nea trees, fences or huts over which they climb and many of them ar allowed to remain as perennials (e.g., *Pè-seik-cho*, *Pè-kadipa*, *Pè pazūn*, *Wêt-swè*, *Pè-napya*). Of these races the seed is far mor expensive than that of field races.

Owing to the fact that the seeds of Dolichos are very susceptibl to the attacks of weevils (much more so than those of Phaseolus) an consequently on account of the difficulties of storage, the crop is nc popular among cultivators. In spite of this, however, considerabl quantities are available for export from the principal producing areas Like Phaseolus, the crop is bought by brokers and shipped to Rangoo and elsewhere. Large quantites of the seed, especially of *Pè-gyi*, ar consumed by all classes of the population. The Chinese and Burmes are particularly fond of it when roasted. The roasting is carried ou by mixing with sand in iron pans over a slow fire. The seeds are als frequently roasted with turmeric and salt, eaten in curries, fried in oi or sprouted and boiled. The green pods of the garden varieties ar almost invariably used as vegetables for curries and "*hin-cho*," bu those of the field varieties are not utilised in this way. On the othe hand, whilst the seeds of the field varieties are consumed, those of th garden varieties are seldon eaten and used only for sowing.

The vines, both green and in a dry state, are regarded as excellen food for cattle.

B.—Dolichos biflorus, Linn.

Low-growing annual herb with slightly twining downy stems an branches.

Leaves trifoliolate, *leaflets* pilose, entire, membranous, broadly ovate, acute, 1 " to 2 " long, *laterals* oblique, *stipules* ovate-lanceo late (0·25 " to 0·5 "), scariose, basifixed, *stipels* minute.

Flowers yellowish green, 1 to 3 together in the axils of the leaves each on a separate, short, curved peduncle; *calyx* downy; *teeth* lanceo late, setaceous, equalling or much exceeding the tube in length *bracteoles* ovate, minute; *standard* ovate-emarginate, longer than th wings and the keel, hardly reflexed, yellowish green with a red patcl about the centre ; *wings* narrow, oblong-oblique, blunt; *keel* narrow obtuse; *stamens* diadelphous; *anthers* uniform, basifixed; *styl* filiform, persistent, penicillate round the stigma, not bearded on inne curve.

Pod linear (about 2" long and 0·25 " to 0·33 " broad), recurved rostrate from the persistent style, dehiscent, downy, not constricte between the seeds; *valves* tough, chartaceous.

Seeds 5 to 7 per pod, rhomboidal, lenticular, flattened, grey to dark red; under magnification, the lighter-coloured seeds are seen to be finely speckled with brown; *hilum* small, inconspicuous.

Size of seed:—

L. 0·2″—0·25″

B. 0·15″—0·17″

T. 0·08″—0·1″

Weight per 100=2·7 gms., or 1050 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Pè-bi-zât.	
Chaung-u		
Singu		
Minbu		
Magwè		
Meiktila		
Myingyan		
Pakôkku		

Notes.

Pè-bi-zât is cultivated only to some extent on islands (*Khine* land) rom October to April and on *Yâs* from September to February. Very little care is bestowed on the cultivation; the ground is worked with the "*htūn*," and the seeds scattered and harrowed in. No weeding or after-cultivation is given. It is often sown mixed with other crops.

The seed is sometimes parched and eaten, but more usually it is boiled with water to a soft pulp which is then pounded with salt, fermented and made into a "relish" or sauce ("*Pè-bouk-yè*" or "*Pong-yè*") that made in *Pägán*, where its manufacture is a large industry, being called "*Pägan Pong-yê*." *Pong-yê* is a thickish, dark brown, treacle-like liquid with an acid taste and the odour of boiled gram; it resembles the "*Sô-yū*," or Chinese sauce made from *Pè-ngapi* (*Glycine hispida*) in Mandalay and is used by the Burmans in the same way as the latter.

PSOPHOCARPUS TETRAGONOLOBUS, DC.

Goa Bean; Chevaux de frise Bean.

Twining annual or biennial plant with all parts green and glabrous.

Stem moderately thick, slightly ridged and grooved with two distinct grooves on the lower side with a ridge lying between them, procumbent.

Leaves trifoliolate; *leaflets* broadly ovate, retuse to sub-retuse or sub-deltoid, acute; *laterals* slightly oblique; *petioles* deeply grooved on the upper side; bases very much thickened; *petiolules* also much thickened; *stipules* small, lanceolate each way from the attachment; *stipels* lanceolate, sessile.

Peduncles up to 6″ long, slender; *racemes* lax, axillary, few-flowered (2 or 3, more usually 2, which are then opposite on the geminate pedicels); *tumours* small and rounded; *bracteoles* ovate, persistent, cupped over the sides of the rugose calyx, somewhat spurred at the base; *calyx-cup* large; *teeth* shorter than tube, ovate, rounded, slightly rugose, the two upper connate; *corolla* large, much exserted; *standard* much reflexed, oblate to orbicular, deeply emarginate, white or lilac splashed with green below the middle, back very pale green; *wings* irregularly obovate, with anchor-shaped spurs, white or lilac; *keel* obliquely obovate, incurved, white or lilac tinged with green on the ridge or elbow; *stamens* diadelphous; *anthers* uniform; *ovary* sub-stipitate, many-ovuled; *style* long, recurved; *stigma* terminal, globose, enclosed in a tuft of soft, woolly, white hairs.

Pods 6″ to 9″ long and about 1″ broad, linear-oblong, flattened, rostrate, four-angled,—the angles being continued into crisped or curled wings which are more or less serrate or dentate; *valves* tough, distinctly septate (often obliquely) between the seeds.

Seeds tumid, short-ovoid to sub-spherical or, sometimes, retuse, yellow to brown in colour; *hilums* large, oval.

Roots tuberous, fusiform, dense-fleshed, invested with a finely-suberous, fibrous, brown bark which is easily removed.

A race with lilac-blue flowers sometimes occurs in a field of the common pure white-flowered Pè-myit.

Size of seed:—

L. 0·3″—0·4″

B. 0·3″—0·34″

T. 0·23″—0·27″

Weight per 100=28·35 gms., or 100 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Pè-myit and Pè-saung-ya.	Grown as a field crop.
Amarapura		
Kyauksè		
Yamèthin		
Meiktila		
Lashio	Pè-saung-ya, To-pon or Hto-pong.	
Hsipaw		
Hsumsai State ...	To-pon or Hto-pong Pè-myit-sa.	
South Hsenwi State ...	San-to-nan, Pè-saung-sa.	
Prome	Pè-saung-ya or Pè-myit.	
Akyab	Pè-myit.	
Sandoway		
Moulmein	Pè-saung-za.	
Hanthawaddy ...	Pè-saung-sa.	
Tharrawaddy ..		
Pegu	Pe-saung-za.	
Henzada	Pè-myit.	
Bassein		
Toungoo		
Karen Hills	Ku-Bemya.	
Mômeik (Katha) ...	Pè-saung-za ...	Greenish yellow seed.
Mogôk	Pè-myit.	
Upper Chindwin ...		

Notes.

Pè-myît is generally described as an annual, but the roots which shoot again if left in the ground would appear to be perennial.

The common variety of the plains of Burma bears a white flower, but a race with lilac-blue flowers frequently occurs scattered in the

fields. The seeds are generally deep-yellow to dark-brown but greenish-yellow to white seeds (Katha) have been obtained from some places, and it is not yet known whether these are the seeds of a separate race or not. It may, however, be noted here that the seed becomes darker in colour on keeping. The Burmese distinguish two races—a long-podded and a short-podded race, but we have been unable to recognise any botanical difference between the two.

Pè-myît is chiefly cultivated for its roots (Myît=root) but also sometimes for its young pods. It is grown almost everywhere in Burma, including the Shan States, whence the supply of seed for the plains is generally obtained.

In the hills the seed is sown about the beginning of the rains, chiefly in gardens or small patches, in rich wet soil. The seed is dibbled about 3″ deep, and 3″ to 6″ apart. Very frequently the land is manured with cattle-manure and, if the rain water is not sufficient, the crop is watered.

Hoeing is resorted to and the soil is frequently pulled up around the roots. Stakes and bamboo trellis-work are often provided for the crop to climb upon and the plants grow up to 10 or 12 feet in height. The roots are ready to dig up by the cold weather and are frequently used for consumption. More generally, however, especially in the Shan States, the crop is left till mature and the seeds are gathered about December or January for sale in Burma proper. The tubers are larger than those produced in Burma but are said to be of inferior quality. In many hill districts the seeds are scattered in small quantities in the *taungyás* generally near tree-stumps which have not been removed. They are left to take care of themselves after the seedlings are once established. A few plants are to be found in the corners of gardens of many villages scattered throughout the hill-tracts. The Northern Shan States, however, is the chief seed-producing area for Burma proper. Large quantities of seed are exported from Hsumsai State under the name of *To-pôn* (or *Htopong*) and also from around Lashio and Maymyo.

In the plains the Goa Bean is generally cultivated under irrigation. The cultivator usually selects his highest ground as this gives the best results; low water-logged land is, as far as possible, avoided. It grows well on moderately stiff clays but the tubers are then large and of less value than moderate-sized ones. A loamy soil or sandy loam is regarded as the best for *Pè-myit* cultivation. The land is deeply ploughed in May or June as soon as water can be obtained and frequently farm-yard manure is scattered and ploughed in. Two or three ploughings are usually given and about July the land is made into "*baings*" (ridges or drills) about 2′ broad and 8″ or 10″ high. This work is carried out partly by the "*htē*" (plough) and completed by the "*paukpya*" (mamootie). The furrow is generally about a foot wide and is used both for irrigation and drainage.

Sometimes locally-grown seed is sown but it is regarded as of little value for the production of fine roots. The seed from the Northern Shan States is generally carried down and sells at a high price—Rs. 7-8-0 to Rs. 10 per basket—whilst local seed is not worth half that amount and is seldom used unless the imported seed is scarce. It is stated that the difference between the seed is due to the fact that the

soil of the plains is always more or less water-logged during the growth of the plant whilst that of the hills is well drained.

When the ridges are ready the seeds are dibbled in from 3″ to 6″, usually about 4″ (*"tamike"* =width of a closed fist) apart. There are various methods of planting, sometimes the seeds are placed in 3 or 4 longitudinal rows on the drill, whilst at others they are planted in short rows running across the drill. The depth of planting is about 2″ and, the seeds being planted very close together, about 2 baskets of seed are required per acre. After sowing, the land is soaked but not flooded with irrigation water, and watering is afterwards carried out, as required, according to the amount of rainfall. Care is always taken that water does not lie on the surface, as excess of moisture reduces the outturn. Weeding is usually carried out by hand and the plants are not staked but allowed to trail along the ground. The tubers are ready for harvest in seven to eight months after sowing. The seeds take a little longer to ripen. The tubers are dug out by men and collected by women, usually by contract; but if the crop is poor, the labour is paid for by daily wages. If the soil is very hard, water is let on to the field to facilitate digging.

In some soils the development of bacterial nodules is extraordinary; the nodules are very large and the Burmese say that they are more plentiful when the plant is grown on land which has remained fallow for one or more years. A crop of tubers which is covered with these nodules is regarded with a certain amount of suspicion and is not altogether a success from a popular point of view. The cultivator, therefore, precedes his *Pè-myît* with a crop of paddy. A very common rotation, especially in Kyauksè District, is, 1st year paddy, 2nd year *Pè-myit*, 3rd year sugarcane, which is sometimes ratooned. The last crop is said to give a 50 per cent. better yield if preceded by *Pè-myît*. The cost of cultivation of this bean is heavy, varying from about Rs. 30 to Rs. 50 per acre, apart from the land and water tax. The yield of roots varies from 1,200 to 1,600 viss per acre, which sell wholesale at from Rs. 4-8-0 to Rs. 10 per 100 viss, according to locality. The profits, after paying taxes, are said to be about Rs. 20 per acre; but in Kyauksè District, where the prices are generally low, the cultivator looks to the succeeding sugarcane crop for his profits. In Mandalay where sugarcane is not grown there is a good market both for the roots and the immature pods, the latter selling at upwards of Rs. 5 per 100 viss.

The garden-cultivation of the plains is similar to that of the hills. The seed is sown in rich soil and a bamboo trellis is supplied for support.

Medium-sized roots, a little thicker than the thumb, are regarded with greatest favour and are the standard size sold, at from 5 to 10 per anna, according to season. Small roots are more appreciated than large ones. They are eaten by the Burmese as a delicacy between meals. For this purpose they are boiled together with rice straw which imparts a reddish colour to the flesh and is further said to soften it. The root is peeled, dipped into a thick mixture of salt and til-seed oil and eaten. "In Keng Tung the root is said to be

used as a material for making a poultice for the head and neck in cases of vertigo".

The tender pods, usually called *Pè-zaung-ya-thi* from their resemblance to the fruit of *Zaung-ya-thi* (Averrhoa Carambola, Linn) are plucked and eaten locally in the same way as French Beans. The ripe seeds are believed to be intoxicating and are therefore not eaten: but " in Java they are eaten after being roasted in iron pots until the shell cracks off ".

There is a large trade carried on in the roots which are exported from the chief districts of Central Burma especially to all parts of Lower Burma but to some extent also to the Shan States and to Northern Burma (Bhamo, etc.). The crop is sold to brokers who sort the roots and afterwards sell them to retail traders. There appears to be always a lively demand for the root, though the pods are seldom carried from one district to another.

Cajanus indicus, Spreng. Pigeon-pea.

An erect woody shrub, up to 8′ in height, with slender stems and silky, sulcate branches ; perennial in nature but usually cultivated as an annual.

Leaves—trifoliolate ; *leaflets* lanceolate to oblong-lanceolate, silky-hairy, minutely gland-dotted beneath, close-veined, veins grey and prominent on the lower surface ; *stipules* ovate-lanceolate with a thick median nerve, hairy, basifixed ; *stipels* minute, linear, setaceous.

Inflorescence—a short, axillary raceme, or a terminal panicle of such racemes ; *flowers* 2 to 6 per raceme, erect or subpendulous on long pedicels arising all along or near the end of the peduncle ; *bud* falcate, truncate ; *calyx* campanulate, 0·25″ long, cleft above the middle into short triangular teeth each with a median nerve, the two upper teeth sub-conate, the three lower spreading, downy like the pedicels and peduncles ; *bracteoles* none; *corolla* much exserted, longer than the pedicel ; *petals* equal ; *standard* sub-orbicular or obovate, slightly emarginate, yellow throughout or streaked and splashed with reddish-purple with a yellow centre (in some of the Burmese races the back of the standard is bright red throughout) ; *wings* obovate, obliquely rounded or blunt, bright yellow ; *keel-petals* obtuse, with somewhat incurved tip, greenish ; *stamens* diadelphous, tube curved upwards beyond the middle ; *anthers* uniform, ovate-lanceolate, dorsifixed ; *pistil* delicate ; *ovary* short, sub-sessile, clothed with short hairs, few-ovuled ; *style* naked, long, filiform, upcurved ; *stigma* capitate.

Pods—solitary, paired, or in clusters up to 6 in number, oblong, flattened, narrowing to both ends, torulose, rostrate from the persistance of the lower half of the style ; septate, three-to-five-seeded, indehiscent ; *valves* somewhat stiff, obliquely and deeply depressed between the seeds, finely downy; when unripe, green throughout or green marbled with purple ; when dry uniformly brown or brown marbled with dark purple.

Seeds 3 to 5 per pod, sub-globular and slightly laterally compressed, varying considerably in colour ; *hilum* oval and, usually, flat but protruding and prominent in the generally somewhat longer seed of *Be-chiang* (Chin Hills) and allied races ; *strophiole* distinct especially in the larger-seeded races.

Variety (1) :—(C. indicus, bicolor, DC.).

A large shrub 6′ to 8′ in height, with more or less erect branches.
Inflorescence terminal and confined to the upper parts of the twigs.
Flowers large, yellow streaked with purple, back of standard often purple throughout.
Pods large, 2½″ long and ⅜″ broad, broadly streaked with purple, tapering gradually to both ends, borne in clusters of 3 or 7 on ends of branches.
Seeds 4 to 5 per pod, light grey speckled or marbled with purple.
Race (*i*) :—

Seeds almost white (grey finely speckled with red).

Size of seed:—
L. 0·2″—0·25″
B. 0·2″—0·25″
T. 0·2″

Weight per 100=11·27 gms., or 252 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Pè-sin-gôn.	
Meiktila District ...		
Myingyan		
Yamèthin		
Southern Shan States ...		
Thayetmyo		
Minbu		

Race (ii) : –
Seeds marbled (grey with purple).
Size of seed:—
L. 0·2″—0·25″
B. 0·15″—0·25″
T. 0·15″—0·2″

Weight per 100=9·32 gms., or 304 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Chin Hills	Pè-sin-gôn, or Be-chaing (Tiddim).	

Race (iii):—
Seeds black, somewhat smaller than Race (ii).
Size of seed:—
L. 0·15″—0·25″
B. 0·05″—0·25″
T. 0·15″—0·2″

Weight per 100=8·72 gms., or 325 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Southern Shan States ... (Yawnghwè and Taunggyi)	Pè-sin-gôn.	

Race (*iv*) :—

Seeds white speckled with black. This is most probably an intermediate form between Races (i) and (iii).

Size of seed :—

L. 0·15″—0·25″
B. 0·15″—0·25″
T. 0·1″—0·2″

Weight per 100 = 8·56 gms., or 331 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Yawnghwè	Pè-sin-gôn.	

Race (*v*) :—

Seeds greyish mottled with brown or purple. This is also most probably an intermediate form derived from the black, as it is generally found mixed with the latter.

Size of seed :—

L. 0·2″—0·25″
B. 0·2″—0·25″
T. 0·15″—0·2″

Weight per 100 = 9·32 gms., or 304 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Yawnghwè	Pè-sin-gôn.	

Variety (2) :—

A large bush 6′ to 8 in height with more or less erect branches.

Inflorescence like Variety 1.

Flowers slightly smaller, yellow throughout, standard more reflexed than Variety 1.

Pods green throughout drying to brown, more abrupt at the ends, slightly smaller than but borne like Variety 1.

Seeds like Variety 1, Race (i).

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Pè-sin-gôn	The distribution of this Variety is not known beyond the Mandalay District.

Variety (3).—(C. indicus, flavus DC.).

A profusely branched shrub with spreading branches 3′ to 6′ in height.

Inflorescence scattered on short branches over the plant.

Flowers yellow throughout, smaller than in Variety 1, standard much reflexed.

Pods green or slightly streaked with brown, small, tapering at the ends, 1·75″ long and 0·3″ broad.

Seeds usually 3 per pod, seldom 4 or 5, small, yellow to reddish brown, not speckled or marbled.

Size of seed:—

L. 00·2″—0·25″
B. ·2″—0·25″
T. 0·15″—0·2″

Weight per 100=9·25 gms., or 306 seeds per oz.

Distribution.

Locality.	Local name.	Remarks.
Mandalay	Pè-sin-gôn.	
Maymyo		
Singu		
Chaung-u (Sagaing) ...		
Meiktila		
Hanthawaddy... ...		
Insein		
Magwè		
Toungoo		
Pegu		
Chin Hills	Hpyan.	

Notes.

Pè-sin-gôn is widely distributed, though not extensively cultivated, in Burma. We do not think that the above distribution is by any means complete, as it only includes those places from which the seeds have been so far received. Owing to the prevalence of cross-fertilization which appears to take place between the different varieties and races, it has been somewhat difficult to make a satisfactory classification. Many intermediate forms are found to occur especially under Variety 1, and, though Variety 2 appears at present to be distinct, it may be found to be an intermediate form between Varieties 1 and 3. Again, the few streaked pods observed in Variety 3 may have been due to cross-fertilization with Variety 1.

This pea is found growing, a few plants together, in gardens or household plots throughout the greater part of the country. Along the navigable rivers, railway lines and other easily accessible places in which natives of India have made their homes, the common variety found is *Variety* 3 (*C. indicus flavus, DC.*) which seldom appears very far from these lines of traffic. On the other hand *Variety* 1 (*C. indicus, bicolor, DC.*) is more frequently found grown as a field-crop in the interior though it also occurs near lines of communication. For this reason the latter variety is most generally regarded as the chief indigenous race of Burma whilst the former is considered an introduced Indian variety. In 1909-10, these two varieties were tested at Mandalay and it was found that the indigenous variety not only yielded almost twice as heavily as the Indian, but, owing to the fact that the fruits are much larger (almost twice as large) and are borne in clusters, the cost of harvesting, which is more than ordinarily expensive in the cultivation of this crop, is very much smaller. Moreover, the plant is taller with more upright and fewer branches and the seeds are almost double the size of the imported kind. The market price is the same for both varieties or usually slightly in favour of the Burmese *Pè-sin-gôn*.

The cultivation of *Pè-sin-gôn*, as a field-crop in Burma, is comparatively recent but appears to be extending. The chief districts where it is found are Meiktila and Yamèthin where it is scattered from June to August, mixed with sessamum. After the sessamum is reaped, which takes place three months from the date of sowing, the *Pè-sin-gôn* is allowed to stand to maturity. It is also cultivated in the hilly districts both as a pure and as a mixed crop. It is sown at any time during the rainy season and reaped during the hot weather. The method of cultivation is of the simplest—the land being roughly ploughed and the seeds scattered and harrowed in. There is no after-cultivation. The pods are plucked by hand and generally threshed by beating with a stick.

The seed-rate and yield are not accurately known and are difficult to estimate as the crop is seldom sown pure on the plains. A little seed about one-eighth to one-fourth basket per acre, according to the discretion of the cultivator, is mixed with the sessamum before the latter is scattered. The yield from a mixed crop will be seldom more than eight or ten baskets per acre. This is worth from Rs. 3 to Rs. 3-8-0 per basket (one basket=about 75 lbs). The whole crop is

consumed locally, none being available for export; in fact large quantities appear to be annually imported from India for consumption by natives of India. As the value of the crop is coming to be recognised by the Burman cultivator it is anticipated that its cultivation will extend in the dry districts and imports of this product will gradually decrease. Although, in Lower Burma, *Pe-sin-gôn* is grown on high land, it is seldom utilized as food by the Burman; but, in Upper Burma, the value of the pea as an article of diet is much more appreciated. The ripe seeds are eaten cooked in curries, or the meal mixed with turmeric, salt, chillies and other condiments is made into cakes (*paya-gyaw*) that are fried in sessamum or groundnut oil. The young pods and immature seeds are cooked and eaten like those of the common pea (*Pisum sativum*). The value of the crop as a soil-fertilizer does not seem to be yet known in the country.

A Glossary of the Botanical Terms used.

A

Abruptly Pinnate—(See under Pinnate).
Acuminate—ending in a sharp, more or less prolonged, and tapering point.
Acute—ending in a narrow angle which, though evenly tapering, is not prolonged.
Adnate—when dissimilar organs are joined to one another over the greater part of their surface and grow together.
Adpressed—flattened down; lying flat for the whole of its length.
Alae—the two lateral petals ("wings") of a Papilionaceous corolla.
Alternate—placed on opposite sides of the stem but on a different line.
Androecium—the male organs of a flower taken together.
Annual—a plant which dies after producing seed within the year in which it sprouts.
Anterior—position in front; outward; facing away from the main axis or stem.
Anther—that part of a stamen which contains the pollen; the essential part of the male organ of a flower.
Apex—the tip or summit.
Apical—pertaining to the Apex.
Apiculate—ending in a short sharp point.
Aril-like—swollen and fleshy.
Auriculate—having a flat lateral expansion shaped somewhat like the lobe of the ear.
Axil—the upper angle formed between the axis of the stem and that of any organ arising from it, *e.g.*, the angle between the stem and the leaf-stalk.
Axillary—produced in or growing out from an axil.

B

Base—the point of attachment of an organ to the stem or to another organ; also the region lying in the immediate neighbourhood of this point.
Basifixed—attached by the base.
Beaked—ending in a gradually narrowing hard tip or point.
Bearded—provided with tufts of hair.
Biennial—a plant which lives for two years,—growing in the first year and dying after flowering, fruiting, and seeding in the second.
Bifurcate—divided into two branches or forks.
Blunt—ending in a rounded point.
Bract—a rudimentary or modified leaf between the calyx and the foliage leaves and usually placed on the peduncle or pedicel.
Bracteate—having bracts.
Bracteole—a secondary bract, usually small, and placed immediately below the calyx.
Branched—divided into parts.
Bristle—a stiff hair or slender spinous point.

C

Caducous—dropping off early, *i.e.*, before the maturity of the part that bore it.
Calli—small thickened processses, expansions or protuberances.
Calyx—the first or outermost set of floral leaves placed immediately below the corolla.
Calyx-cup—the cup-shaped or tubular lower portion of the calyx formed by the lateral union of its parts (the sepals).
Calyx-teeth—the usually narrow and pointed free upper ends of the sepals.
Calyx-tube—(see calyx-cup).
Campanulate—bell-shaped.

C—continued.

CAPITATE—pin-headed, *e.g.*, capitate stigma; growing in heads or short compact masses, *e.g.*, the recemes of *Peyin*.
CARPEL—a simple pistil or modified seed-bearing leaf.
CARUNCLE—a wart or protuberance.
CAUDATE—tail-like; furnished with a tail.
CHARTACEOUS—thin and flexible; of the consistence of paper.
CIRCINNATE—curled round and coiled in like a crook or crozier, *e.g.*, a young fern-leaf.
CLAVATE—club-shaped; slender below and gradually thickened towards the upper end.
CLAWED—with narrow bases.
CLEFT—divided some way towards but not quite up to the base.
COBALT—sky-blue; light-blue
COMMON PETIOLE—(see under Petiole)
COMPOUND—not simple or single but consisting of several parts or divisions.
COMPOUND LEAF—a leaf consisting of several leaflets.
CONGESTED—crowded.
CONNATE—when similar organs or parts of an organ are united together throughout their existence.
CONSTANT—always present
CONTINUOUS—not separated by partitions; forming one undivided chamber.
CONTORTED—twisted into a spiral.
CORDATE—heart-shaped; broad and notched-in at the base.
COROLLA—the second set of modified leaves (the petals) forming the usually coloured and attractive part of the flower.
COTYLEDON—seed-leaf
CRENATE—having rounded teeth.
CRISPED—curled.
CRUMPLED—irregularly folded.
CULTURE—experimental growth or cultivation.
CUNEATE—wedge-shaped; tapering from a broad upper end to an acute angle at the base.
CYLINDRICAL—round like a rod or pipe.

D

DECIDUOUS—falling in season; dropping off on the cessation of functional activity.
DEFLEXED—bent outwards or downwards.
DEHISCENT—splitting, at maturity, into definite parts.
DELTOID—shaped like a delta or equilateral triangle.
DENTATE—having the margin cut into teeth pointing outwards.
DEPRESSED—pressed down; sunk; placed in a hollow.
DIADELPHOUS—when the stamens are connected by their filaments into two fascicles or bundles.
DIFFUSE—widely and loosely spread; scattered.
DIGITATE—radiating from a common apex as centre; arranged like the fingers of the open hand.
DIMORPHOUS—occurring under two distinct forms; produced in two different forms.
DISTAL—the free end apposite the point of attachment.
DISTANT—when similar parts are not close together.
DISTICHOUS—arranged in two opposite and vertical ranks or rows.
DISTINCT—separate; unattached; clearly visible.
DISTRIBUTION—localities of growth or cultivation.
DORSAL—pertaining to the back.
DORSIFIXED—fixed on or by the back.
DOWNY—provided with down or soft hairs lying close together.

E

ELBOWED—forming a sharp angle, like the elbow of the bent arm.
ELLIPSOID—a solid whose outline is elliptical.

E—concld.

ELLIPTICAL—oval or oblong with regularly rounded ends.
ELONGATE—drawn out in length.
EMARGINATE—having a notch at the apex.
ENSIFORM—sword-shaped; straight with an acute point.
ENTIRE—with an even or uncut margin.
EQUAL—of the same length.
ERECT—upright.
EXFOLIATION—a peeling off.
EXSERTED—extending or protruding beyond.
EXTENSIVE—spreading.

F

FALCATE—shaped like a sickle-blade.
FASCICLE—a close group or cluster of flowers.
FERTILE—capable of producing fruit and seed.
FILAMENT—the stalk of an anther.
FILIFORM—thread-like in form; long and slender.
FLACCID—limp; flabby; weak.
FLEXUOSE—bent alternately in opposite directions; zig-zagged.
FREE—not adnate to another body; not connected with nor adhering to anything else.
FUSIFORM—spindle-shaped; thick about the middle and tapering towards the ends.

G

GEMINATE—in pairs; two together.
GENUS—the smallest natural group of plants containing distinct but closely related smaller groups called species.
GIBBOUS—enlarged, like a pouch, on one side.
GLABRESCENT—slightly glabrous; almost hairless; nearly smooth.
GLABROUS—without hairs or roughness.
GLAND—a warty swelling or protuberance which may or may not be engaged in secretion.
GLAUCOUS—covered with a fine white or bluish-grey bloom.
GLOBOSE—almost spherical or round like a ball.
GRANULATE—covered with little knots or grain-like processes.
GYNAECEUM—the entire female portion of the flower.

H

HERB—an annual plant, made up of soft tissues which perish after the period of its growth.
HERBACEOUS—not woody but cellular and succulent; producing annual stems from a perennial root.
HILUM—the scar on a seed indicating the point of its attachment to the stalk on which it was borne and through which it was nourished.
HORIZONTAL—level; standing out at right angles from the stem.
HYBRIDIZATION—the production of plants by the pollen of one species being placed, naturally or artificially, on the stigma of another; the crossing or interbreeding of species.

I

IMPARIPINNATE—(See under Pinnate).
INDEHISCENT—not splitting at maturity in a definite manner.
INDENTED—deeply and narrowly depressed.
INFLEXED—turned or bent abruptly inwards.
INFLORESCENCE—the disposition or arrangement of the flowers on the floral axis; the floral axis with the flowers upon it.

K

KEEL—in a Papilionaceous corolla, the member, resembling the prow of a boat formed by the union of the two innermost anterior petals.
KEELED—singly and more or less sharply ridged.

L

LAMINA—the blade or expanded part of a leaf.
LANCEOLATE—narrowly elliptical and tapering to each end; shaped like a lance or spear.
LATERAL—fixed near or upon the side of anything.
LATERALS—the leaflets to the right and left of the common petiole of a compound leaf.
LAX—not compact or congested but loosely or distantly arranged.
LEAF—the principal lateral organ or appendage of the stem.
LEAFLET—one of the divisions of a compound leaf.
LENTICULAR—shaped like a doubly-convex lens with a more or less sharp edge or border.
LINEAR—narrow, several times longer than broad, with the two sides parallel or nearly so.
LINEATE—deeply marked, transversely, with lines.
LOBED—divided into lobes or broad teeth.
LUNATE—shaped like a cresent.

M

MEDIAN—belonging to the axis or middle.
MEMBRANOUS—thin and semitransparent, like a fine skin.
MICROPYLE—the minute hole, opposite the apex of the radicle, in the outer coat of a seed.
MONADELPHOUS—when the steamens are united by their filaments into one tubular bundle or sheath.
MONILIFORM—like a string of beads, with alternate swellings and constrictions.
MUCRONATE—ending abruptly in a hard sharp short point.

N

NAPIFORM—shaped like a turnip-root; round, like a ball, but depressed at the top.
NERVE—a simple (unbranched) vein or slender rib.
NODE—a knot or joint.

O

OBLATE—flattened at the ends and distended at the sides.
OBLIQUE—of unequal sides; slanting.
OBLONG—much longer than broad, with nearly parallel sides.
OBOVATE—rounded at the ends but broader at the distal than at the basal end.
OBOVOID—a solid whose outline is obovate.
OBTUSE—blunt or rounded at the end.
OPPOSITE—set against one another on the same node and on the same line.
ORBICULAR—flat with a circular or almost circular outline.
ORDER—a group of genera bearing close natural relationships to one another.
OVAL—broadly elliptical.
OVARY—that part of the pistil which contains the young seeds and usually ripens into the fruit.
OVATE—the opposite of obovate; broader at the basal than at the distal end.
OVOID—a solid whose outline is oval or ovate.
OVULE—the young seed before it is fertilised.

P

PAPILIONACEÆ—a suborder of pod-bearing plants the corollas of which are Papilionaceous.
PAPILIONACEOUS—shaped like the Papilio or butterfly.
PEDICEL—the support or stalk of a single flower; the last or ultimate branch of the inflorescence.
PEDICELLATE—furnished with a pedicel; borne on a stalk.
PEDUNCLE—the common stalk of several flowers; the axis of a floral cluster (it sometimes supports a single flower).
PENDULOUS—drooping; hanging down.
PENICILLATE—furnished with a tip or tuft of fine minute hairs.
PERENNIAL—a plant which lasts for several years.
PERSISTENT—not falling off, but lasting till the maturity of the part which bears it.
PETIOLE—the stalk of a leaf.
COMMON PETIOLE—the stalk which is common to and supports all the pinnæ or leaflets of a compound leaf.
PETIOLULE—the stalk of a leaflet.
PILOSE—provided with soft distinct scattered hairs.
PINNA—the primary division or leaflet of a pinnate leaf.
PINNATE—with leaflets arranged along each side of a common petiole
(*a*) ABRUPTLY PINNATE—when there is an equal number of pinnæ or leaflets on each side of the common petiole.
(*b*) IMPARIPINNATE—when, in addition to being abruptly pinnate, an odd pinna or leaflet is borne at the apex of the common petiole.
PISTIL—the female organ of a flower, consisting, normally, of ovary, style and stigma.
POD—a dry, two-valved, many-seeded, usually indehiscent, fruit like that of the Pea and Bean.
POLLEN—the usually yellow-coloured dust-like grains produced and contained in the anthers of flowering plants.
POSTERIOR—next or towards the main axis or stem; the opposite of Anterior.
PROCUMBENT—lying along the ground.
PROMINENT—standing out beyond, or raised above, the surface of anything.
PROPHYLL—one of a pair of usually simple leaves borne immediately after and above the cotyledons.
PUBESCENT—clothed with soft simple hairs or down.

R

RACE—used, in this Book, in a loose sense to denote a series of individuals which are related to one another "without particular regard to rank".
RACEME—a simple inflorescence of indefinite length in which the distinctly and equally-stalked flowers are borne singly over the greater part of the peduncle.
RADICLE—the first simple root of an embryonic plant; the axis of the embryo below the cotyledons.
RECURVED—bent or curved backwards or downwards.
REFLEXED—abruptly recurved.
RENIFORM—kidney-shaped.
RETUSE—as if cut across, with the centre of the cut end somewhat depressed.
RHOMBOID—quadrangular, with the lateral angles obtuse.
RIDGE—a raised line on the surface of an organ.
ROSTRATE—beaked.
RUGOSE—thrown into wrinkles; covered with wrinkled lines the spaces between which are ridged or convex.
RUGULOSE—somewhat wrinkled.

S

SACCATE—bag-shaped.
SAGITTATE—shaped like an arrow-head.

S—concld.

SCABRID—somewhat rough from the presence of short stiff hairs.
SCARIOSE } —thin, dry, and membranous, not green.
SCARIOUS }
SEAM—a raised line or delicate ridge.
SEMISAGITTATE—sagittate on one side of the long axis.
SEPALS—the floral leaves forming the calyx.
SEPTATE—separated into chambers by partitions.
SERRATE—beset with sharp saw-like teeth that point forward.
SESSILE—attached directly, without a stalk.
SETACEOUS—bristle-like.
SHRUB—a woody perennial branched to the base.
SIMPLE—consisting of only one distinct part; not divided or branched; not compound.
SINUOUS—with a wavy or recessed margin.
SOLITARY—only one from the same place; growing singly; standing alone.
SPATULATE—oblong, with the basal end narrowed.
SPECIES—a group of individuals whose distinctive characters are such as point to a common descent, being alike in all important respects.
SPICATE—like a spike, or arranged in a spike or spikes.
SPIKE—a simple inflorescence which resembles a raceme but differs from it in that the flowers are stalkless.
SPIRAL—resembling a coil wound round an axis.
SPURRED—clawed; provided with processes resembling claws or spurs.
SQUAT—short and, proportionately, broad.
STAMEN—one of a set of thread-like floral leaves consisting of a stalk (filament) supporting a head (anther) which bears the pollen or essential male element.
STANDARD—the fifth, posterior, or odd petal of a papilionaceous corolla.
STIGMA—that part of the pistil which receives and holds the pollen.
STIPE—a stalk supporting the ovary.
STIPEL—the scale-like leaf borne on a petiolule; an appendage to a leaflet.
STIPELLATE—having stipels.
STIPITATE—provided with or borne on a stipe.
STIPULE—a scale-like leaf borne on a petiole; an appendage to a leaf.
STIPULATE—having stipules.
STRIÆ—fine longitudinal lines, markings, ridges or furrows.
STRIATE—marked with striæ.
STROPHIOLE—an appendage, like a swelling, to the hilum of some seeds.
STYLE—the usually narrow, column-like, tubular part of the pistil arising from the top of the ovary and supporting the stigma.
SUB—under or next lower in rank to; somewhat or almost but not quite; nearly; slightly.
SUBORDER—a group of genera lower than an order.
SUB-RACE—a form whose variation from a race is slight.
SUB-SPECIES—a group of forms of doubtful rank between a variety and a species.
SUB-VARIETY—a trifling variety or form of some other more definite and typical form.
SUBEROUS—corky in texture.
SUBULATE—narrow and pointed; awl-shaped.
SUCCULENT—soft-fleshed; juicy.
SULCATE—furrowed; grooved.
SUTURE—a seam or line indicating the make of union or separation of two different parts of the same organ.

T

TEETH—small divisions or incisions.
TENDRIL—a twining sensitive thread-like process by which some weak-stemmed plants climb up supports.
TERETE—cylindrical and usually tapering.
TERMINAL-LEAFLET—the odd leaflet of a compound leaf borne at the end of the common leaf-stalk.

T—concld.

TESTA—the outer usually hard and brittle coat of the seed.
TETRAGONOUS—four-angled or four-edged.
TOMENTOSE—densely covered with short hairs.
TORULOSE—cylindrical with slight constrictions and swellings at intervals.
TRAILING—prostrate, but not rooting at the nodes or joints.
TRIFOLIOLATE—with three leaflets.
TRUNCATE—ending abruptly, as if cut across.
TUBE OF CALYX—(see Calyx-cup).
TUBE OF STAMENS—in a Papilionaceous flower, the hollow bundle of united stamens.
TUBEROUS—resembling tubers, or short, thickened and fleshy underground stems bearing leaf-buds, at intervals, at the nodes.
TUMID—swollen and firm.
TUMOUR—a firm swelling.
TURGID—swollen and tense.

U

UNDERSHRUB—a low shrub the ends of whose branches die annually after the period of growth.
UNDULATE—wavy.
UNIFORM—of the same form or kind.

V

VALVE—one of two parts or pieces into which the carpel of a pod, like that of the bean, separates at maturity.
VARIETY—a group of individuals which shows some slight but distinct modification from the characters of a recognized specific form.
VEIN—one of a fine mass of thread-like fibres found in the generally expanded body of a leaf.
VENATION—the arrangement of the veins in a leaf.
VENTRAL—pertaining to the front or inner surface.
VERSATILE—turning freely or swinging round on its support.
VIRGATE—shaped like a wand or twig; narrow and cylindrical.
VISCOUS—sticky, clammy.

W

WING—an ala; any membraneous expansion.
WRINKLED—rugose; creased; thrown into fine folds.

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Department of Agriculture, Burma

BULLETIN No. 12 of 1914

THE PEAS AND BEANS OF BURMA

BY

E. THOMPSTONE, B.Sc.

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RANGOON

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NOTE ON THE SOIL OF THE EXPERIMENTAL FARMS

BY

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RANGOON

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NOTE ON THE GOVERNMENT EXPERIMENTAL FARM SOIL.

During the course of work on the soils of the Government Experimental Farms in Burma a general problem regarding availability of Phosphoric acid (P_2O_5) in paddy soils has been disclosed. This is now being studied more fully.

In the meantime the preliminary results which refer to the experimental farm soils and may therefore be of value for field work are here recorded.

The soils used for these experiments need not be described in detail. It will be sufficient to note the main resemblances and differences which exist between them.

With respect to texture the soils fall into the following groups :—

Padu-Black Mandalay	Heavy clay.	Hopin Tatkôn	Sandy loam.
Hmawbi Kyauksè	Clay.	Bugyi Padu-Red	Sandy soil.
Pwinbyu ... Clay loam.			

Of these soils Padu-Black, Mandalay and Kyauksè are alkaline. Pwinbyu, Padu-Red and Tatkôn are neutral, Bugyi and Hopin slightly acid and Hmawbi strongly acid.

In Humus content Hopin, Tatkôn and Padu-Black are high, Hmawbi, Pwinbyu and Kyauksè medium. Mandalay for a clay soil contains a low percentage of humus. The sandy soils contain very little organic matter.

Padu-Black though containing much clay is more easily worked than the Mandalay soil. This difference must be attributed mainly to the higher humus content of the former. It is at least possible that the organic matter of the Mandalay soil could be profitably increased.

The accompanying soil analysis table shows the results of extraction on the ignited soil by hot concentrated hydrochloric acid for 8 hours.

TABLE I.

Name of Soil.	Mandalay.	Hmawbi.	Tatkôn.	Pwinbyu.	Padu-Black.	Padu-Red.	Bugyi.	Hopin.	Kyauksè.
Insoluble Residue ...	52·31	63·87	79·46	62·67	46·09	82·37	85·90	72·27	55·51
Soluble Silica ...	21·27	15·26	7·55	12·90	21·57	7·37	5·97	11·12	15·27
Ferric Oxide (Fe_2O_3) ...	4·76	3·63	3·17	6·41	6·17	2·00	1·88	3·28	4·56
Alumina (Al_2O_3) ...	12·59	10·07	4·90	10·61	15·67	4·77	3·43	6·62	9·89
Lime (CaO) ...	·99	·29	·48	·56	1·27	·16	·28	·48	4·34
Magnesia (MgO) ...	·50	·29	·27	·33	·47	·17	·19	·56	·67
Potash (K_2O) ...	·99	·57	·33	·77	1·09	·41	·23	·38	1·03
Soda (Na_2O) ...	·69	·36	·22	·52	·29	·08	·11	·30	·16
Sulphuric Acid (SO_3) ..	·04	·08	·06	·07	·03	·02	·02	·04	·08
Phosphoric Acid (P_2O_5)	·04	·03	·06	·13	·05	·06	·02	·04	·06
Carbondioxide (CO_2) ..	·31	·02	·04	·12	·21	·05	·05	·02	8·58
Organic matter plus combined water.	5·51	5·53	3·36	4·91	7·09	2·51	1·92	4·94	4·35
Total ...									
Organic Carbon ...									
Organic Nitrogen ...	·058	·072	·108	·110	·0420	·059	·040	·109	·114
Available Phosphoric Acid.	·0106	·0029	·0302	·0489	·0173	·0115	·0322	·0104	·0162
Available Potash ...	·0560	·0804	·0672	·0568	·0656	·0780	·0328	·0424	·0640

The total P_2O_5 (Phosphoric acid) was determined in a separate sample by extraction with nitric and hydrochloric acids. Available potash and phosphoric acid were determined by the usual citric acid extraction method.

Considering first the figures for the heavy soils the analyses show that there is a very marked difference between Padu-Black: Mandalay and Kyauksè on the one hand and the Hmawbi soil on the other.

The three former are alkaline, contain free $Ca\ Co_3$ (Calcium Carbonate) and large amounts of magnesia and potash. Whilst the last is acid, lacks free $Ca\ Co_3$ (Calcium Carbonate) and contains relatively small quantities of magnesia and potash.

The Hmawbi soil has evidently either suffered a great deal of leaching out *in situ* or has been formed of material already leached out.

The agricultural differences between the three first mentioned clay soils are considerable and must depend largely upon the amounts of free $Ca\ Co_3$ (Calcium Carbonate) and humus they contain.

Pwinbyu though somewhat lighter than the clays just discussed and therefore scarcely to be compared with them, holds, it may be noted, an intermediate position.

It is neutral in reaction and its content of lime, magnesia and potash while less than that of the alkaline soils is distinctly higher than that of Hmawbi.

It is the most productive soil in this table.

Tatkôn is also a rich soil. It is further characterised by a high content of organic matter. It should be important in the case of this soil, which has only just been brought under cultivation, to observe the effect of regular cultivation on the humus content.

Hopin must be considered a marsh soil. It is somewhat acid and the humus in it is to a notable extent uncombined with lime. This state of affairs seems hardly to be ideal for wheat cultivation but is apparently favourable to the growth of paddy which yielded larger crops on Hopin than on any other soil examined.

Neither chemical analysis of the soil nor yields from pot-cultures indicate any lack of potash.

Analyses of the crop show however that paddy absorbs less than the normal amount of potash from this soil and the deficiency is not due to unusual absorption of alkali earth.

This peculiarity may be caused by the marshy nature of the soil.

The chief contract from the chemical point of view between the two sandy soils is in their content of P_2O_5 (Phosphoric acid) (total and available).

Padu-Red is found to be remarkably rich and Bugyi exceptionally poor in this respect.

With a collection of soils varying to such an extent in texture, reaction and humus, nitrogen and phosphoric acid content, we cannot well expect to find what effect small differences in nitrogen or other soil constituents can have on the yielding power of the soils in question.

Should there exist, however, one factor which has a predominant effect on the yield it may be expected to become noticeable. Pot experiments distinctly indicate something of the kind.

Pot-culture Tests.

As the pot-culture tests were made entirely with paddy the conclusions refer only to this crop.

Before discussing the pot-culture results a few remarks regarding the errors involved in such work are necessary.

From several years' experience it has been found that eight pots are an unnecessarily large number and that equally reliable figures may be expected from the average of four pots. This shows that growth is usually remarkably uniform. It is worth noting also that all the soils so far tested could be easily distinguished from one another by mere inspection of the unmanured crops they bore. Manuring of course frequently accentrates the differences.

The figures given in the following tables are averages of either duplicate or triplicate tests which agreed well with one another, and every test made has been included.

The results obtained therefore were quite consistent and, although by themselves perhaps they cannot carry as much weight as averages from a large number of tests would, it has been found possible to lend further support to some of the conclusions by analysing the crops grown.

Yield of Paddy from Unmanured Soils.

The yields of paddy given in the accompanying table are in each case averages from three pots.

TABLE II.

	Soil.	Soluble Silica.	Nitrogen.	Yield of Paddy.	
				Seed.	Straw.
Clays.	Padu-Black	21·57	·042	6	8
	Mandalay	21·29	·058	10	13
	Hmawbi	15·26	·072	12	13
	Kyauksè	15·27	·114	16	22
	Pwinbyu	12·90	·109	28	37
Silts.	Hopin ...	11·12	·109	49	93
	Tatkôn	7·55	·103	29	31
Sands.	Padu Red	7·37	·059	36	39
	Bugyi	5·77	·039	25	28

The soils have been arranged in order of Soluble Silica content. This figure may be assumed to represent sufficiently accurately the order of permeability of the soils.

The table shows that where comparable soils are concerned the yield is distinctly governed by the nitrogen content of the soils. The first two and the last two soils form good examples of this.

It is quite clear however that there is no general agreement between the Nitrogen content and yield.

By reference to the soil analyses table it will be seen that the same remark applies to soil reaction, humus content and presence of larger or smaller amounts of P_2O_5 (Phosphoric acid) K_2O (Potash), MgO (Magnesia). For example amongst the lowest yielders we have three alkaline and one strongly acid soil.

Again of the two soils really deficient in P_2O_5 (Phosphoric acid) according to chemical analysis one gives a good yield and the other a very poor yield.

The effect of any one of these factors may in the case of similar soils, which vary only in one important constituent, be considerable, but it can only be gauged when such similar soils are examined.

In the case of the present soil collection such effects are entirely masked.

In dealing with the present diverse soil collection the very fact that the important constituents enumerated have no definite connection with the relative yields lays emphasis upon the parallelism between soil texture and yield.

This parallelism is by no means strict, but generally the table points to the fact that the heavier soils yield less than the lighter, and that the soil texture exerts a more marked effect upon yield than the soil reaction or the presence of larger or smaller amounts of plant food.

The explanation of this result no doubt rests on Harrison's work which showed the importance of percolation for the development of the paddy plant.

There is at present no clue to the exceptionally high yielding power of the Hopin soil.

Development in relation to Manuring.

The manurial tests with these soils consisted of:—

1. Tests with nitrogen alone (4 grns. Am_2So_4 per pot).

2. Tests with nitrogen + phosphoric acid (4 grns : Am_2So_4 + 4 grns. super-phosphate).

The final crop weighings showed a great increase due to Nitrogen in every case but the effect of Phosphoric acid was marked only in four cases.

The final crop weighings however reveal only a part of the facts. It has been found very useful in addition to note the rate of development of the plants.

For this purpose measurements of the crop in each pot were made once a month.

It is true such measurements are not very accurate but the differences to be observed were so great that the figures obtained have a very definite value and show interesting features. In the accompanying table the numbers represent the average volume of the plants per pot.

TABLE III.

Month.	Mandalay Soil.			Hmawbi Soil.			Tatkôn Soil.		
	Unmanured.	Nitrogen.	Nitrogen plus Phosphoric acid.	Unmanured.	Nitrogen.	Nitrogen plus Phosphoric acid.	Unmanured.	Nitrogen.	Nitrogen plus Phosphoric acid.
September	63	86	450	77	150	450	170	400	400
October	132	430	850	220	570	925	380	825	825
November	134	525	900	200	775	810	420	825	800
December	189	628	1,040	290	750	1,000	470	960	945

TABLE III—concld.

Month.	Pwinbyu Soil.			Padu-Black Soil.			Padu-Red Soil.		
	Unmanured.	Nitrogen.	Nitrogen plus Phosphoric acid.	Unmanured.	Nitrogen.	Nitrogen plus Phosphoric acid.	Unmanured.	Nitrogen.	Nitrogen plus Phosphoric acid.
September	210	400	350	60	60	290	270	400	400
October	430	925	825	100	350	...	430	800	900
November	480	900	825	100	485	650	540	800	860
December	500	1,050	960	140	550	790	600	900	950

Month.	Bugyi Soil.			Hopin Soil.			Kyauksè Soil.		
	Unmanured.	Nitrogen.	Nitrogen plus Phosphoric acid.	Unmanured.	Nitrogen.	Nitrogen plus Phosphoric acid.	Unmanured.	Nitrogen.	Nitrogen plus Phosphoric acid.
September	200	350	400	290	375	400	190	190	330
October	390	900	950	950	...	...	880	650	860
November	940	1,000	930	950	1,800	1,700	815	570	900
December	830	1,000	1,000	1,050	2,200	2,400	350	690	1,070

This table shows most definite effects of P_2O_5 (Phosphoric acid) in certain cases, especially if we look at the earlier stages of development.

4. Soils namely Mandalay, Hmawbi, Padu-Black and Kyauksè show very marked increases due to P_2O_5 (Phosphoric acid), whilst Tatkôn, Pwinbyu, Padu-Red and Bugyi show no benefit at all.

It is noticeable that the effect is seen at a very early period and is in fact at that stage most marked.

The differences originally observed though maintained to the end become less marked as development proceeds.

A reasonable explanation of this result is that in cases where P_2O_5 (Phosphoric acid) is more difficult to obtain the development is slower but tends, under favourable conditions of climate and water, eventually to proceed until the nitrogen supplied has been utilised.

Observations on the colour of the plants support this view.

The excess of Nitrogen over P_2O_5 (Phosphoric acid) is indicated by the dark green colour of the plants which persists for several months in the Nitrogen pots of the soils poor in P_2O_5 (Phosphoric acid).

The colour of the plants in soils rich in P_2O_5 (Phosphoric acid) and in poor soils to which P_2O_5 (Phosphoric acid) has been added soon becomes lighter—the colour change being accompanied by rapid increase in volume of the plant.

It is important to note that when lack of P_2O_5 (Phosphoric acid) is made good by manuring (third column) the growth in all the soils becomes almost identical.

This shows that the retarded development on the four poor soils is not due to some effect of peculiar texture but to an actual lack of P_2O_5 (Phosphoric acid) in the soils. Whether these soils require more P_2O_5 (Phosphoric acid) simply to overcome toxic effects does not of course concern us here.

A comparison of these pot results with the chemical analyses of the soils is of interest. The analytical table would indicate that Hmawbi and Bugyi were exceptionally poor and Tatkôn and Pwinbyu exceptionally rich in P_2O_5 (Phosphoric acid), whilst the remaining soils occupied an intermediate position and little or no difference was to be expected amongst them.

The pot-cultures show no relationship whatever to these figures.

Again it is found that the pot experiments have merely separated out the four heavy soils, which by this test are all seen to be lacking in P_2O_5 (Phosphoric acid) whilst the lighter soils show no deficiency.

Effect of Soil on composition of Crop.

To corroborate as far as possible the above results relating to availability of soil Phosphoric acid, the crops obtained from pot-cultures were submitted to analysis. Seed analyses were not made because preliminary work has shown that P_2O_5 (Phosphoric acid) content of the seed seldom falls far below the normal figure and it does so only when the straw is exceptionally poor.

A poor straw may therefore be considered a sufficiently satisfactory index of lack of available P_2O_5 (Phosphoric acid) in a soil.

The following table shows percentage P_2O_5 (Phosphoric acid) and Nitrogen in stalk and leaf. For reference also average yield of straw per pot is given.

TABLE IV.

Name of Soil.	Manured with Am_2So_4.					Unmanured.				
	Yield of Straw.	Per cent. Composition.				Yield of Straw.	Per cent. Composition.			
		Phosphoric acid.		Nitrogen.			Phosphoric acid.		Nitrogen.	
		Stalk.	Leaf.	Stalk.	Leaf.		Stalk.	Leaf.	Stalk.	Leaf.
Padu-Black ...	87	·069	·048	·257	·407	8	·064	·063	·314	·444
Mandalay ...	45	·087	·057	·296	·457	13	.093	·070	·307	·432
Hmawbi ...	57	.150	·069	·319	·374	15	·124	·086	·420	·483
Kyaukse ...	61	·171	·085	·292	·568	25	·105	·046	·366	·412
Pwinbyu ...	104	·332	·147	·249	·412	39	·255	·098	·276	·401
Hopin ...	284	·330	·169	·272	·677	104	·321	·213	·381	·529
Tatkôn ...	53	·314	·168	·230	·413	32	·240	·108	·381	·475
Padu-Red ...	90	·329	·183	·257	·424	41	·431	·186	·327	·424
Bugyi ...	96	·196	·094	·265	·420	25	·318	·152	·385	·492

The soils have been arranged here in the order of their permeability.

It is obvious that the same soils which showed a distinct reaction with P_2O_5 (Phosphoric acid) are again the only ones which yield straw poor in this constituent.

The relation found to exist between composition of leaf and stalk is interesting but requires no notice here except in so far as it demonstrates the remarkable regularity of development of paddy in the pot experiments quoted. Such regularity has not been observed in field cultures.

Before accepting the figures of Table IV as conclusive evidence of lack of P_2O_5 (Phosphoric acid) in the soil the possibility that straw composition may be seriously affected by the extent of ripening must be considered.

Ripening of paddy in pot-cultures may be expected to depend to some extent at least on the size of the crop, and as the four soils which gave straw poor in P_2O_5 (Phosphoric acid) all yielded small crop, the question of unequal ripening becomes significant.

Figures referring to manured and unmanured pots of any one soil (*e.g*, Kyauksè, Pwinbyu, Tatkôn) do in a few cases show that with the larger crop there is a less complete transference of P_2O_5 (Phosphoric acid).

The differences are however usually so small that they cannot be considered to point to appreciable differences in ripening. Further in the case of the Bugyi soil the opposite result is obtained.

This in connection with the soil analyses figures which showed Bugyi to be very poor in P_2O_5 (Phosphoric acid) is interesting, because, although the pot-culture crop yields indicated no deficiency the larger (manured) crops on this soil have evidently grown up with less than the usual proportion of P_2O (Phosphoric acid).

With most of the soils there is little or no difference between the unmanured small crop and the manured larger crop.

The first soil on the list for instance gives much the same amount of P_2O_5 (Phosphoric acid) in the straw whether the yield per pot is 8 grammes (unmanured) or 37 grammes (manured with Am_2So_4).

On the other hand comparing equally developed crops from different soils we see that 37 grammes straw from manured Padu-Black soil is very poor in P_2O_5, whilst the straw weighing 32 and 41 grms. (from unmanured Tatkôn and Padu-Red respectively) are both rich.

Further one would expect that any serious differences in ripening would affect the seed straw ratio. There is no evidence from this point of view that the soils which yielded straw poor in P_2O_5 permitted a more complete ripening of the plant.

It may be taken as satisfactorily proved therefore that the pot crops whether large or small were all practically equally ripened at harvest and therefore the differences found in straw composition must be due to differences in availability of the Phosphoric acid in the soils.

Summarising the results so far obtained it is seen that, with the soils employed Citric acid extraction forms no criterion for the amount of P_2O_5 available for a paddy crop.

Pot-cultures show that a shortage of $P_2 O_5$ is felt at a very early stage. This shortage in the case of a long-lived variety grown under favourable conditions is in time more or less made up as the plant develops.

Under unfavourable climatic conditions it is possible that the plants could not make up for the initial setback. This point seems worth careful observation in field cultures.

As far as our farm soils are concerned and whatever the reasons may be the experiments show that the normal yields of paddy from the four heavy soils are least and that these soils also are deficient in $P_2 O_5$.

The figures for total and available $P_2 O_5$ given in the soil analysis table, though they have little or no connection with the present requirements of the paddy crop are undoubtedly an index of the total supply of this substance and its state of occurrence.

The significance of the figures well only be cleared up by systematic observations on manurial field tests.

F. J. WARTH,

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BLACK THREAD DISEASE OF HEVEA IN BURMA

BY

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1916

"BLACK THREAD" DISEASE OF HEVEA IN BURMA.

I.—Black Thread.

The name "Black Thread" is given by the Burma rubber planters to a diseased condition of the stem of *Hevea brasiliensis* in which the tapped tissues, laid bare by tapping, become disfigured and damaged by the appearance of vertical, slightly depressed black lines. These follow the tapping cut as it is continued down the stem and extend in through the cambium into the wood. The blackening of the tissues runs along the tapped area and eventually covers the whole cut. Diseased areas soon become vertically cracked, especially under wet conditions, and markedly sunken. From the vertical cracks white latex occasionally exudes and at times there is quite a copious flow (Fig. 1). In some cases there is a thick wad of coagulated latex between the diseased renewing bark and wood; in these cases the cambium is completely destroyed and there is always a bulging out of the diseased renewing bark (Fig. 2). This soon decays leaving behind a big gaping wound, exposing the wood, *i.e.* a true "canker" is formed. The black diseased portions cease to yield latex. The finer the tapping the worse the disease, because the cambium is more easily attacked and destroyed. It is this damage to the cambium which constitutes the most serious feature of the disease, for it is upon the activity of this tissue that the tree depends for the smooth and even regeneration of the bark cut away during tapping. When the cambium has been damaged but the infected area is small, narrow wounds extending down to the wood are formed. These wounds get healed, but the renewal is naturally not smooth, as in the renewal of healthy tapped areas, but rough with vertical swollen ridges of wound tissues; and where the decayed bark has left open wounds, there is no normal renewal of the bark, but there is a formation of callus which ultimately becomes gnarled and irregular. The final result of the disease is that the tree is left without any smooth bark on which tapping can be recommended. In no case has a tree been found to die of this disease.

II.—The cause of the disease.

Sections through diseased areas show the cell walls turned brown or yellow and in some cases swollen and the cell contents destroyed. In some cases the stratification of the swollen cell wall appears very distinct. The cell cavity is sometimes filled with a yellow or brown gummy substance. On account of the death of the protoplasm and the loss of the water contents of the cell, the cell walls shrivel. The depression of the diseased area may be due to this collapse of the cell walls of the outer tissues. It is in these swollen and diseased cell walls that unseptate hyphæ are to be found. The constant presence of intercellular and non-septate hyphæ in the diseased tissues strongly suggested the genus *Phytophthora*, one species of which has been reported to be the cause of the well-known canker of *Hevea*.

At this time the fruits hanging on trees were found to be attacked by a *Phytophthora*. The presence of the disease on the fruits can be marked from a distance by the exudation of latex in drops. The diseased areas are at first unhealthy, dull green in colour and look water-logged, and subsequently assume a dark tint. In some cases a thin layer of coagulated latex is found between the outer soft green tissues

and the woody shell of the seed capsule, similar to the wad of latex found on the stem between the renewing bark and the wood. With the advent of bacteria and saprophytic fungi the whole fruit turns black. When the fruits are attacked in the early stage of their development they do not dehisce, the seeds are not liberated, and the soft rind of the fruits split at the sutures; the fruits remain hanging on the trees for a long time. The disease in Burma has not been found to attack the fruit stalk. If the fruit gets diseased when it is about to ripen, it dehisces normally and liberates healthy seeds, if the attack is not severe; but in cases of severe attack the seeds have been found to be diseased and rotten. On the diseased parts of the fruits, not long after they get attacked a white felt of mycelium is produced bearing numerous sporangia. These are small pearshaped fruiting bodies of the fungus. They either liberate motile organisms, called zoospores, which swim about in water and are capable of infecting healthy fruits and newly-opened parts of the stem or the sporangia directly give rise to germ-tubes which also infect healthy tissues and produce the disease. These sporangia have but very rarely been found on diseased parts of the stem.

III.—Inoculation experiments.

In order to verify that a *Phytophthora* was the cause of the "Black Thread" disease, inoculation experiments with pure cultures obtained from diseased fruits have been carried out. The inoculations were at first done by putting a bit of the mycelium on a newly-tapped surface; the inoculated areas were kept covered from 24 to 48 hours with cotton soaked in sterilised water. In four days the inoculated areas showed signs of successful infection; they had turned either black or had vertical black lines and had become slightly depressed. Within a week they showed typical symptoms of "Black Thread." Vertical cracks were present on the inoculated areas and in some cases there was even exudation of latex in drops. Sections from inoculated areas showed the presence of intercellular hyphæ in the tissue which had turned brown, as in the case of naturally diseased tissues.

Inoculations in a similar way were also made on renewing bark and old bark; the results of similar numerous inoculations on saplings and trees of all ages showed that the fungus is capable of attacking the tree only through wounds. Inoculations made on uninjured parts of stems and branches invariably failed, while those on the wounded surface were successful. Some of the successful inoculations have also produced sporangia.

IV.—The spread of the disease.

The fungus *Phytophthora* belongs to a group of fungi which are very dependent upon a copious supply of moisture for their existence and the dissemination of their spores. Any factors therefore which serve to increase and maintain a moist atmosphere round the tree trunks would favour this disease. One of the plantations visited was very badly affected, though it was well drained and very cleanly kept. In 1914, roughly 12,000 trees were affected out of 77,000 bearing trees Last year, 42,000 trees were removed from the tapping round on account of the disease out of 117,000 tapping. In 1914, the loss of rubber is estimated at 2 to 3 thousand pounds and last year between 8 to 9 thousand pounds. In 1914, tapping was prevented only on 7

days on account of rain and in 1915 on 10 days ; so the major part of the loss is the result of the disease. At Twante the trees are planted 20 × 20 feet apart and are never pruned ; they therefore form a think canopy of interlocking branches beneath which sunlight is at a minimum and humidity at a maximum. At another plantation the climatic conditions (rainfall, etc.) were the same as at the first and yet the disease was much less severe. This is to be attributed to the fact that, although the trees are planted 10 × 10 feet apart, heavy pruning is indulged in, and thus more light penetrates to the trunks and freer circulation of the air takes place through the plantation. That sun and light are important factors in checking the disease can be seen even at the former plantation where the trees on the boundary of the estate are much less seriously affected than those in the interior.

The disease first makes its appearance soon after the rains break out and completely disappears after the close of the monsoon. Even during the monsoon the progress of the disease is checked during a long spell of dry and sunny weather. The disease progresses when rainy days again set in.

The annual recurrence of the disease on the stem has not been found to originate from the infected areas of the previous year ; but has been observed to be due to fresh infections.

On an infected tree the disease spreads downwards following the tapping cut; if tapping is stopped, the spread of the disease is stopped. This is what would be expected from the discovery that the fungus is a wound parasite. The fungus, however, lies dormant when tapping is stopped during the monsoon and resumes its activity when tapping is resumed any time during this period.

V.—Treatment of the disease.

A hundred diseased trees were experimented upon. They were divided into two lots, A and B, of 50 trees each. A was treated with Burgundy mixture once every week and B untreated ; 25 trees of each A and B were stopped from being tapped. It was not possible to continue tapping the treated part of the stem as the latex coming in contact with the fungicide would yield takky rubber. The tapping on the remaining 25 trees of lot A was therefore done 4 to 6 inches below the original cut, while the remaining 25 trees of the lot B were tapped as usual ; 25 trees which were healthy at the commencement of the experiment were kept as controls. The newly-opened surface of the trees of lot A that were being tapped soon became diseased as the result of fresh infections. The controls also developed the disease. Those of the lot B on which tapping was continued grew worse, while on those of the lots A and B which were removed from the tapping round, the progress of the disease was checked. There was no difference between the treated and untreated trees ; the treatment, therefore, did not seem to have any effect. When after 5 weeks some of these trees were opened at the original cut, there were found faint traces of the presence of the disease on the newly-opened cut and those traces were in continuation of the old diseased area. When tapping was continued for 3 or 4 days the disease became quite prominent. Below the unopened surface the disease had progressed very little. The first cut showed faint traces of the disease, but the disease had not advanced further as was seen when more cuts were

made simultaneously with the first. The tissues exposed by these subsequent cuts were quite healthy. In a similar condition were the old tapped areas of the remaining plants of lot B in which fresh cuts were made a few inches below the original cuts.

These experiments show that the fungus remains dormant in the tissues during the monsoon when tapping is stopped and resume its activity when tapping is resumed.

The disease seems to be one of those that may be met by the promotion of general hygienic conditions within the plantation. Those measures which would ensure penetration of sunlight and free circulation of air through the plantation require to be adopted; in thickly planted plantations trees should be thinned out and judicious pruning indulged in before the rains set in. This thinning out and pruning may result in less yield of latex, but the loss is only temporary for the advantages gained would ultimately more than repay it. According to Skinner thinning out of closely-planted areas leads to an increase in the yield of No. 1 rubber, a quicker renewal of the bark and a substantial reduction in the running expenses Seventy to eighty trees to the acre according to local conditions have been found by Skinner to have yielded excellent results. A plantation having such widely spread trees would have sufficient sunlight and free circulation of air to discourage the attack of "Black Thread."

On the 1st of August when the trees had almost shed their fruits, 25 young trees were opened which had never previously been tapped. In the course of the month several more new trees were opened and all with one doubtful exception were found in September to be perfectly healthy, though there was more or less rain every day of the month except on one day and though the total rainfall for this month was higher than that for June or July. This result coupled with the fact that the fungus fructifies very profusely on the fruit but very poorly on the stem that in nature the fruit gets diseased before the stem, and that the fungus from the fruit has been shown to successfully inoculate healthy tapped areas leads to the conclusion that the fruits are a grave source of infection and therefore should be collected and burnt or disposed of at some distance from the plantation by burying with lime. In a badly-infected area it would be well to collect and destroy all the fruits before the rains set in; in other cases it might be sufficient to systematically collect diseased fruits as soon as they are found to be diseased.

The above measures are, of course, all preventive; in the case of an area which already has the disease the best thing would be to stop tapping diseased trees and to go in for thinning out, pruning and destruction of all fruits. In Java, where a similar disease is known, Rutgers recommends, as a curative measure, the stopping of tapping and treating the tapping cuts with a 20 per cent. solution of Carbolineum plantarium or some other disinfectant every 5 days. After a few weeks tapping may be started again; in some cases, he thinks, it is not necessary to stop at all.

J. F. DASTUR, B.Sc.
1st Assistant to the Imperial Mycologist.

PUSA, *January* 1916.

G. B. C. P. O.—No. 116, 9(*e*), D. of A., 16-5-1916—650—R. E. R.

FIG. 1.

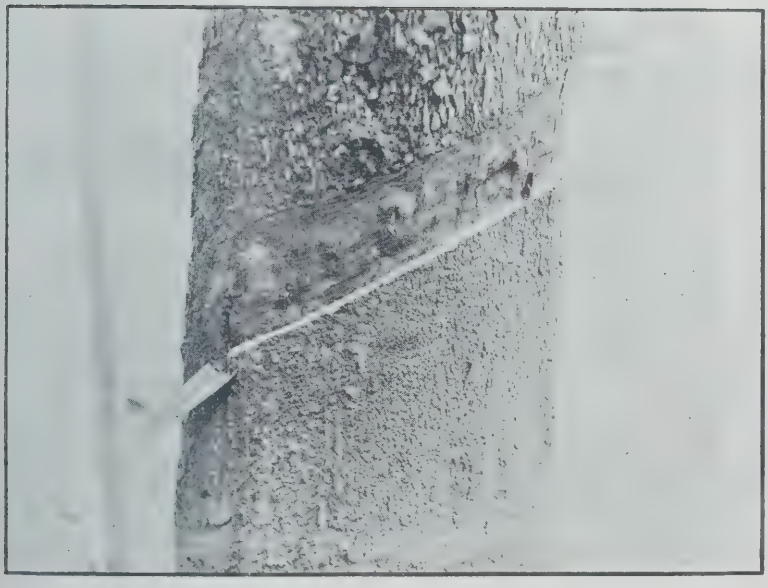

FIG. 2.

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SUBJECT.

No.

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2 Chafers (Po Kyaing Gaung) and Chafer Grubs (Po Di Gaung).
3 Farmyard Manure, Dung or Cattle Manure.
4 The Cultivation of Groundnut.
5 Red-Rot Disease of Sugarcane.
6 Introduction of Moulmein Paddy into the Akyab District.
7 Cultivation of English Vegetables, Cabbage, Cauliflower, Lettuce.
8 Cultivation of English Vegetables, Turnip and Kohi-Rabi or Knol-Khol.
9 Cultivation of English Vegetables, Carrot, Raddish Beet and Parsnip.
0 Cultivation of English Vegetables Peas, Broad Beans, French Beans.
1 Cultivation of English Vegetables, Onions and Leeks.
2 Tobacco Cultivation.
3 Cultivation of Maize.
4 Cultivation of Cotton.
5 Cultivation of Jute.
6 The use of small Bullock Hoe (Tun-d).
7 The Palm Beetle or Rhinceros Beetle.
8 The Preservation of Mixtures of Sessamum and Groundnut Oil.
9 The Red Cotton Bug.
0 Sunn Hemp Cultivation.
1 The Seed-drill.
2 The Angle Harrow.
3 The Pyaungsabin (ပြောင်းတားပင်) (Striga Lutea).
4 The Rice Hispa.
5 The Swarming Paddy Caterpillar (Spodophera Mauritia-Boised).
6 The Mandalay Agricultural Station
7 The Lemon Butterfly.
8 Two useful Rice-pounders used in the Shan States.
9 Cultivation of Castor-oil Plant.
0 List of Implements recommended by the Department.
1 What kind of Paddy to grow and how to obtain pure seed.
2 The Common Hairy Caterpillar, Burma "Ku" (ခု) (Diacrisia obliqua.—Wik).
3 Fruit Flies.
4 The Spotted Boll Worm (ဝါဆိုင်းတားဒိုး)
5 The Brown Coccid (ဝါဆိုင်းစုတ်ဒိုးဝါ) (Ceroccus Hibisci Green).
6 Cultivation of the Para Rubber Tree, published in Burmese only.
7 Field Crickets (ပရုပ်)
8 Anthreanose. (A Disease of the Cotton Plant)—Not translated into Burmese and for circulation in the Amherst District.
9 Dry-weather Cultivation of Burmese Vegetables on Paddy Soils.
0 Winnowing Machine.
1 Chain Pumps.
2 Anti-Rinderpest Serum.
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4 The Symtoms of "Ufra" Disease of Rice.

Department of Agriculture, Burma

BULLETIN No. 14
1916

BLACK THREAD DISEASE OF HEVEA IN BURMA

BY

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1ST ASSISTANT TO THE IMPERIAL MYCOLOGIST, PUSA

RANGOON

OFFICE OF THE SUPDT., GOVERNMENT PRINTING, BURMA

1916

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Department of Agriculture, Burma

BULLETIN No. 15
1917

THE MANDALAY MILK SUPPLY

BY

F. J. WARTH, M.Sc.,
AGRICULTURAL CHEMIST, BURMA

RANGOON
OFFICE OF THE SUPDT., GOVERNMENT PRINTING, BURMA
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1916

AN absolute necessity for this enquiry was the collection of a large number of typical samples of unadulterated milk from individual animals and from herds.

These were procured through the co-operation of my assistants Maung Po Saw and Maung Po Shin and the Probationary Assistantst Ko Ko Gyi and Maung Tun Ye who all personally supervised the milking of the animals.

This was an essential and also a trying task.

In the preliminary enquiries on which the scheme of sampling was eventually based Maung Po Saw and Maung Tun Ye collected much useful information. I wish to acknowledge and commend the spirit in which the work was carried out by my assistants.

F. J. WARTH,
Agricultural Chemist, Burma.

THE MANDALAY MILK SUPPLY.

1.—Quantity of milk available.

Of the total milk used in the town about $\frac{3}{5}$ is obtained from cows kept within the Municipal limits. A certain number of these animals is stall fed but must obtain some grazing. The grazing is done in the vicinity of the town on reaped fields when these are available, at other times on fallow land, roadsides, etc.

A common practice is to keep the animals in the jungle pasture until they calve. They are then brought into the town and stall fed during their lactation period. Though some of these animals are not stationary it may be assumed that almost all of them are entered in the statement of Agricultural stock in Mandalay Town prepared for the season and crop report. According to this statement there were during 1915-16, 2,439 cows in Mandalay.

The yields for a number of herds in different parts of the town have been determined and from these a rough estimate may be made of the total yield.

The actual figures obtained are given here.

Milk yields of some herds in Mandalay.

TABLE I.

(1)	Total cows (2)	Milking cows. (3)	Daily milk yield (lb.). (4)	Yield per milking cow. (5)
East ...	212	70	350	5·00
North ...	167	64	263	3·12
West ...	146	53	171	3·25
South ...	169	63	204	3·25
	694	250	988	3·90

Therefore 2,439 cows would yield 3,472 lb. or roughly 3,500 lb. milk a day from cows kept in the town.

This refers to the yield during the rains.

From general experience here it may be assumed that the yield would fall to 2,100 lb. in the cold weather and would drop further to 1,800 in the hot months.

The volume of the milk traffic from the surrounding villages is surprisingly large when the method of its transport is taken into consideration.

A small quantity is brought in by cart but most of it is carried in kerosene tins by coolies from distances of 8—10 miles in some cases.

The villages from which the bulk of this outside milk is obtained and the routes along which it is brought are shown in a small map.

The total quantity of milk obtained from these sources is about 2,000 lb. a day during the rains and falls to about half this amount in the cold weather.

From these figures it appears that the daily supply to Mandalay during the rains is well over 5,000 lb. and this shrinks in the hot weather to a minimum of about 3,000 lb.

There is not the least doubt that milk production in the jungle is much cheaper than in the town. It may be added that cattle in the jungle villages live under more natural conditions and also that dairy work is beneficial to agriculture.

It is true that the jungle producer has difficulties in transport and marketing to contend with at present but these are not insuperable and if overcome would lead to a cheaper milk supply for the town.

The town milk producer has no transport or marketing difficulties but his animals have little or no grazing and all the fodder he requires has to be brought from considerable distances. The cost of this cartage must be very much greater than that required for first class transport of milk from the jungle to town.

We should therefore look to the jungle suppliers to effect improvements in quality and quantity of the milk used in Mandalay.

2.—Composition of Mandalay Milk.

To obtain samples for determining average composition of milk of Mandalay cows a number of herds were selected in different parts of the town and milked under supervision. The analytical results are given in detail in Table II.

TABLE II.

Mandalay Town Milk (Herd Samples.)

Sample number. (1)	Total cows. (2)	Milking cows. (3)	Yield. (4)	Yield per cow. (5)	Specific gravity. (6)	Freezing point. (7)	Per cent. nitrogen. (8)	Per cent. proteid. (9)	Per cent. fat. (10)	Per cent. total solids. (11)	Per cent. total solids not fat. (12)	Gravity plus fat. (13)
East No. 9	50	21	109	5·19	1·031	−·542	·638	4·070	4·15	13·18	8·88	35·2
East No. 10	60	15	102	6·80	1·031	−·543	·660	4·210	5·04	13·47	8·43	36·0
East No. 11	37	8	33	4·12	1·031	−·535	·687	4·386	5·23	...	...	36·2
East No. 12	10	6	33	5 50	1·032	−·550	·807	5·146	6·52	...	...	38·5
East No. 13	30	12	45	3·75	1·031	−·555	·634	4·045	4·38	...	...	35·4
East No. 14	25	8	28	3·50	1·032	−·545	·635	4·051	4·90	...	...	36·9
			46									
North No. 9	32	9	31	5·11	1·033	−·561	·695	4·434	5·01	14·50	9·49	38·0
North No. 11	30	12	35	2·58	1·033	−·551	·637	4·063	7·02	...	.	37·0
North No. 12	20	8	31	4·37	1·030	−·546	·637	4·066	6·28	...	..	36·3
North No. 13	25	13		2·38	1·031	− 551	·627	1·000	5·53	...	...	36·5
West No. 9	70	22	68	3·09	1·035	−·555	·658	4·196	8·62	13·74	10·12	38·6
West No. 10	40	14	54	3·86	1·035	−·545	·705	4·499	3·93	12·54	3·61	38·9
West No. 11	6	3	7	2·33	1·031	−·550	·797	5·082	5·92	15·51	9·59	36·9
West No 12	15	6	16	2·66	1·035	−·539	·615	3·923	3·12	13·14	10·02	38·1
West No. 13	9	5	18	3·60	1·033	−·555	·682	4·352	3·88	13·11	9·23	36·9
West No. 14	6	3	8	2·66	1·032	−·545	·681	4·344	4·11	12·98	8·87	36·1
South No. 9	42	14	43	3·08	1·035	−·555	·607	3·871	4·50	13·95	9·45	39·5
South No. 10	55	19	68	3·58	1·033	−·550	·594	3·789	4·89	14·31	9·42	37·9
South No. 11	12	6	15	2·50	1·031	−·550	·686	4·374	6·98	16·86	9·88	38·0
South No. 12	15	6	18	3·00	1·032	−·550	·629	4· 12	5·83	15·47	9 64	37·8
South No. 13	25	10	26	2·50	1·032	− 570	·606	3·867	5·60	15·09	9·49	37·6
South No. 14	20	8	25	3·12	1·032	−·537	·632	4·034	5·71	16·09	10·36	37·7
												37·3
Average ...	...	...	...	...	1·032	−·549	·661	4·210	5·10	14·25	9·43	37·2

Perhaps the most striking point in these figures is the constancy of the freezing point. They fully bear out Dr. Leather's conclusion (Pusa Bulletin No. 57) that the freezing point is a most reliable test for watering of milk.

The extreme variations correspond to a difference of about 3 per cent. water from the mean whilst the bulk of the figures lie close together. The significance of these results will become evident when we come to examine samples of watered milk.

It may be noted here that the freezing points were determined by the usual Beckman apparatus with one modification, namely, the substitution of the usual glass outer tube by a tin tube. Determinations were naturally carried out much more rapidly by this means. Duplicate readings were not quite constant but the variations observed were entirely negligible for the work in hand.

The fat content is very variable. The general average is high and compares favourably with results obtained in India. It is noticeable that the western town is the only part from which samples containing less than 4 per cent. fat were obtained. Of the six herds tested in this quarter 4 yielded milk poor in fat.

It is noteworthy that these are the only samples in which the proteid content exceeds the fat content.

From the general table it may be safely taken as a rule with Mandalay cows that the fat exceeds the proteid. This is an important point which will be further established and referred to.

The few exceptions to the rule are only found in the western town (where no grazing is available) and are most likely to be attributed to lack of sufficient nourishment of the herds there.

3.—Compoisition of milk from jungle villages.

Complete analyses are given in Table III. It is very noticeable that the proteid is lower and the fat content higher than that of the town samples.

As both the town and jungle samples were obtained from fairly large herds distributed over considerable areas the figures on this point must be accepted as quite convincing.

TABLE III.

Jungle milk (Herd Sample.)

Sample No. (1)	Place. (2)	Specific gravity. (3)	Freezing point. (4)	Per cent nitrogen. (5)	Per cent proteid. (6)	Per cent fat. (7)	Per cent total solids. (8)	Per cent total solids not fat. (9)	Gravity plus fat. (10)
1	Patheingale ...	1·033	−·558	·581	3·704	5·24	14·86	9·62	38·2
2	Thayetkan North.	1·033	−·573	·578	3·683	4·79	14·04	9·25	37·8
3	Hmanbin ...	1·032	−·563	·583	3·722	5·54	14·90	9·36	37·5
4	Ingyai ...	1·032	−·543	·583	3·721	5·37	14·73	9·36	37·4
5	Taungmyin ...	1·033	−·548	·619	3·946	4·95	14·61	9·66	38·0
6	Ngwedaung-ngwe.	1·032	−·563	·605	3·861	6·00	15·66	9·66	38·0
7	Bon-oh ...	1·032	−·583	·570	3·551	5·66	14·66	9·00	37·7
8	Pagyi ...	1·033	−·583	·601	3·836	4·87	14·01	9·64	37·4
9	Aing-gyi ...	1·032	−·560	·629	4·013	6·86	16·74	9·88	38·9
10	Lein-pin ...	1·030	−·563	·549	3·500	6·35	15·14	8·79	36·4
11	Let-kaung ...	1·030	−·568	·533	3·399	4·67	13·18	8·51	34·7
12	Kyauk-mi ...	1·032	−·566	·634	4·042	6·38	16·49	10·11	38·4
13	Nywedaung ...	1·030	−·553	·544	3·471	6·72	15·97	9·25	36·7
14	Yelaung ...	1·031	−·558	·557	3·554	5·74	15·05	9·31	36·7
15	Gon-daw ...	1·031	−·563	·616	3·930	6·65	16·25	9·60	37·7
16	Tawdwin ...	1·032	−·553	·611	3·898	6·16	15·72	9·56	38·2
	Average ...	1·032	−·563	·587	3·739	5·72	15·13	9·41	37·5

They prove that the jungle milk has a distincty higher market value. For this reason again therefore the desirability of developing a milk supply for Mandalay from the surrounding villages is indicated.

The difference in composition is undoubtedly due to feeding and the increased fat is attributable to the better grazing obtained by the jungle cattle.

A further support for this explanation is given by the figures for the cows of western town where low fat content was associated with lack of grazing.

The average freezing point of the jungle milk is distinctly higher than that of the town. The difference however only corresponds to about 2 per cent. water. This is a negligible quantity when the freezing point method is employed to detect addition of water.

In the jungle milk samples the fat content is very decidedly higher than the proteid content.

As the same result though not to such a marked degree and with 4 exceptions was obtained in Mandalay town herds, we can expect this rule to hold with all pure milk sold in the town.

This gives us an additional means of detecting removal of cream.

4.—Comparison of Indian and half-bred with Burmese cows.

The accompanying table IV (*a*) and (*b*) shows the data obtained regarding individual cows.

To determine satisfactorily the average yield and quality of milk from individuals of different breeds would require a much fuller set of determinations than it was possible to make.

The figures show however that generally a distinctly higher yield may be expected from the Indian and the half-bred animals. The fact that the average yields of milk from Burmese cows is very low cannot be denied, it is true also that under the Mandalay town conditions the Indians and half-bred animals are generally not much better, but there is a distinct if small difference in their favour, and this small difference may just mean profit instead of loss. However the arguments for and against introduction of fresh blood cannot be entered into here.

To improve dairy work and the Mandalay milk supply there is

TABLE IV (*a*)

Mandalay Town Milk (Indian and Half-bred cows).

Sample number.	Kind.	Age of calf.	Milk yield per day.	Specific gravity.	Freezing point.	Per cent. nitrogen.	Per cent proteid.	Per cent. fat.	Per cent. total solids.	Per cent. total solids, not fat.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		Months.	lb.							
1E	Indian ...	5	11·5	1·025	−·550	·5241	3·343	4·90	13·01	8·11
2E	Indian ...	7	8·00	1·032	−·553	·5547	3·539	4·75	13·01	8·26
3E	Indian ...	4	9·00	1·030	−·[illegible]95	·4857	3·099	4·57	14·02	9·45
4E	Indian ...	1 ½	12·00	1·031	−·535	·5528	3·527	5·51	14·02	8·51
1N	Half-bred ...	5	12·00	1·032	−·[illegible]86	·4016	2·560	5·21	13·80	8·59
2N	Half-bred ...	2 ½	12·00	1·032	−·521	·5688	3·629	3·87	13·80	9·93
4N	Half-bred ...	4	7·00	1·032	−·581	·5850	3·732	4·43	13·07	8·64
1W	Half-bred ...	2	8·00	1·031	−·562	·5602	3·573	4·17	12·75	8·58
2W	Half-bred ...	5	5·00	1·035	−·555	·6579	4·198	2·16	11·49	9·33
3W	Half-bred ...	4	4·50	1·035	−·545	·6916	4·412	1·99	11·48	9·49
4W	Half-bred ...	6	4·00	1·032	−·542	·6646	4·240	3·99	13·13	9·14
1S	Half-bred ...	7	1·50	1·031	−·567	·6252	3·989	5·36	14·44	9·08
2S	Half-bred ...	5	4·50	1·031	−·560	·7611	4·856	7·69	17·34	9·65
3S	Half-bred ...	2	6·00	1·044	−·537	·6340	4·664	5·22	14·05	8·83
4S	Half-bred ...	2	5·00	1·035	−·550	·5789	3·693	2·65	12·23	9·58
	Average ...	...	7·37	...	−·545	·5986	3·821	4·43	14·18	9·01

Burmese Cows (b)

		Months.	lb.							
5E	Burmese ...	3	6·0	1·030	−·553	·5265	3·361	5·76	14·25	8·49
6E	Burmese ...	3	8·5	1·032	−·[illegible]85	·4729	3·023	4·41	14·25	9·84
7E	Burmese ...	1	6·5	1·032	−·550	·5867	3·743	6·05	15·09	9·04
8E	Burmese ...	3	6·0	1·030	−·545	·5318	3·393	5·45	15·09	9·64
5N	Burmese ...	2	5·0	1·031	−·543	·6676	4·221	5·32	12·12	6·80
8N	Burmese ...	1	5·0	1·030	−·556	·6302	4·021	6·87	13·83	7·46
5W	Burmese ...	2	5·0	1·036	−·555	·7528	4·803	4·41	14·00	9·59
6W	Burmese ...	4	4·0	1·035	−·542	·7046	4·495	3·75	13·26	9·51
7W	Burmese ...	6	5·0	1·035	−·540	·7217	4·605	3·64	13·21	9·57
8W	Burmese ...	6	4·0	1·036	−·535	·8148	5·198	4·94	15·54	10·60
5S	Burmese ...	2	3·5	1·034	−·545	·5365	3·423	3·73	13·25	9·52
6S	Burmese ...	5	3·5	1·032	−·540	·5797	3·698	4·23	13·40	9·17
7S	Burmese ...	2	5·0	1·031	−·550	·7162	4·569	6·98	16·12	9·14
8S	Burmese ...	2 ½	3·5	1·035	−·550	·6209	3·961	3·71	13·34	9·63
	Average ...	...	5·04	...	−·546	...	4·026	4·91	14·05	9·14

no doubt that the milk yield per cow must be increased. Whatever other steps may be taken in the future to attain this object the results of the experimental dairy on the Mandalay farm show that the yields from Burmese cows can be very considerably increased by care and proper feeding.

Regarding composition of the milk of the different breeds it can be concluded that only small differences with no significance are to be expected.

Amongst the half-bred animals there are however three exceptionally low fat figures. Individual Burmese cows from the same herds yielded low fat also but by no means such extreme figures as those from the half-bred animals. (See Table 4.)

The figures are at least suggestive and if the milk enquiry is further prosecuted, the point should be considered.

It is worth emphasising once more that the freezing point figures agree closely with those given in previous tables.

5.—Quality of milk samples from wholesale dealers.

TABLE V.

Dealers' milk.

Sample number.	Specific gravity.	Freezing point.	Per cent. nitrogen.	Per cent. proteids.	Per cent. fat.	Per cent. total solids.
15E	1·029	−0·520	·6023	3·843	4·97	12·73
16E	1·031	−0·550	·5687	3·628	3·13	12·73
15N	1·031	−0·566	·6571	4·192	6·12	13·84
16N	1·027	−0·461	·6061	3·867	4·14	13·84
15W	1·033	−0·570	·6891	4·397	4·31	13·52
16W	1·033	−0·515	·5871	3·746	2·46	11·10
15S	1·032	−0·517	·5455	3·480	4·08	12·93
16S	1·033	−0·535	·6421	4·097	5·29	14·60

The accompanying table shows composition of a few samples from wholesale dealers.

It will be seen that some of the samples give freezing points which diverge noticeably from the normal. This divergence is undoubtedly due to watering.

According to this test sample No. 4 contains 13 per cent. added water. Numbers 1, 6 and 7 contain about 4 per cent.

The rest are practically normal. It can be concluded that the milk is generally delivered in an unwatered state to the dealers.

Enquiry has shown that in many cases the retailers buy the milk after a standard dilution of one part water to four parts milk has been effected by the wholesale dealer in the presence of his retailing

customers. In other cases more or less of the fat is separated as cream by standing or boiling before the milk reaches the market.

Such separated milk is also watered sometimes before being sold.

It is stated that sugar is in some cases added to watered milk.

6.—Composition of milk sold to the public

Forty-two samples of milk were purchased at bazaars and other milk stalls. The samples were collected from every part of the town where milk in any considerable quantity is sold.

The analytical data obtained are shown in Table VII and to make comparison more easy the samples have been arranged according to fat content into five classes, namely (1) those containing 4 per cent. fat and over, (2) between 3 per cent. and 4 per cent. fat, (3) between 2 per cent. and 3 per cent. fat, (4) between 1 per cent. and 2 per cent., (5) under 1 per cent. fat.

Before attempting to determine what adulteration has taken place we must know the composition of the average pure milk available and also the extent of variation from these figures which is to be expected in any single case.

The following data, which are a summary of results from Tables II and III give this information.

TABLE VI.

Average composition of pure Mandalay town and jungle milk.

	Specific gravity.	Proteids.	Fat.	Solids not fat.	Freezing point.	Fat and gravity.
Town	1·032	4·31(±·30)	5·10(±1·00)	9·43(±·43)	—·549(±·008)	37·3(±1·1)
Jungle	1·032	3·74(±·16)	5·72(±·58)	9·41(±·23)	—·563(±·008)	37·5(±·7)
Average	1·032	4·07(±·28)	5·36(±·83)	9·42(±·33)	—·555(±·009)	37·3(±·9)

The figures within brackets indicate the mean deviations of single determinations from the average.

From the mean deviations it is evident that the averages of all except the fat figures are reliable.

For the fat content the probable error of the mean here given is considerable. The average fat content is really 5·36 with the probable error of ±·11.

It was noted earlier that about $\frac{3}{5}$ of the total Mandalay supply was town milk and $\frac{2}{5}$ jungle milk. As the average figures are derived, from 22 town samples and 16 jungle samples they represent fairly closely the composition which average milk sold in the town should have.

Determination of extent of watering.

Of the figures given in the above table the freezing point is seen to be by far the most constant for all pure milk samples.

It is therefore also the most reliable basis for determining the extent of watering (provided of course that the milk is not adulterated in some other way as well). For calculating the extent of watering Dr. Leather's table (Bulletin No. 57) has been used, dilution experiments carried out in the laboratory here having shown that the table applies equally well to Mandalay milk.

The figure for solids not fat was found to be practically identical for the two classes of milk and the variations to be expected are not serious.

The percentage of solids not fat therefore also forms a fairly good basis for determining added water and has been used for this purpose. The proteid content is much too variable to be of use and as the fat content figure ranges within still wider limits, it is obviously out of the question.

In the case of estimation of watering by the fat content of the milk however a much more serious error is likely to be made in another way. This will happen when cream has been removed from the milk. The worst milk sample, for instance, contains only ·61 per cent. fat. To reduce the average fat content to this low figure by watering alone would imply the addition of 400 volumes of water to 100 of pure milk.

We have only to look at the proteid content or the solids not fat to see that so much water has not been added. The low fat in this case is mainly due to removal of cream.

That dilution has however also taken place is evident from the percentage of solids not fat and from the freezing point.

The specific gravity figure by itself is exceedingly misleading if cream has been removed. But by allowing for the amount of fat present in the milk there is no doubt the specific gravity gives useful indications of the extent of watering.

This means has therefore also been employed to determine added water. It will be seen that on the whole there is very close agreement between the results obtained by these three distinct methods.

There are however a few cases in which the freezing point figure diverges considerably from the other two determinations and as in all these the freezing point systematically gives the lowest result, it is possible that we are dealing in some of these instances with adulteration of another kind as well as with watering. These divergences were of course only observed after the analyses had been completed and all the results compared. It was therefore impossible to investigate the point further.

Determination of fat removed as cream.

It has already been noted that in pure Mandalay milk the fat should be in excess of the proteid.

Wherever therefore proteid is in excess as is the case according to Table VII with nearly ½ the samples examined we know that cream has almost certainly been removed.

To determine accurately the amount of fat removed in any single sample is not possible in our case where fat content of the original pure milk is so uncertain.

Later however a figure for the average amount of fat removed is given. This is derived from a large number of determinations and is quite as reliable as the average fat content figure for pure milk.

The results of the examination of the milk bought by the public can now be summarised from Table VII.

First series samples fat over 4 per cent.

Applying the tests above described it can be concluded that cream has not been removed from any of these samples.

Two samples No. 4 and 5 consist of pure unwatered milk. The proteids, fat, total solids are normal and freezing point satisfactory. No. 3 has been watered to the extent 10 per cent. and others 25 per cent. to 30 per cent.

TABLE VII.

Mandalay Town Milk.

	No.	Milk bought at	Rate.	Average quantity sold.	Specific gravity.	Freezing point.	Per cent. nitrogen.	Per cent. proteid.	Per cent. fat.	Per cent. total solids.	Per cent. total solids not fat.	Gravity + fat.	Per cent. added water.		
													By freezing point.	By solids not fat.	By gravity + fat.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
			Rs. A. P.	Viss.											
Series 1 over 4 per cent. fat.	4	Payagyi ...	0 5 0	...	1·032	−·550	·628	4·007	4·71	14·46	9·75	36·7	...	...	1
	1	Thuyeze ...	0 5 0	15	1·023	−·400	·472	3·014	4·41	11·65	7·24	27·4	24	24	26
	40	Zegyo ...	0 5 0	60	1·028	−·438	·571	3·642	4·36	12·49	8·13	32·4	18	13	13
	5	Shore ...	...	...	1·033	−·565	·569	3·634	4·28	13·41	9·13	37·3	...	...	...
	38	Mingalaze ...	0 5 0	12	1·026	−·433	·587	3·747	4·28	11·55	7·27	30·3	19	24	19
	35	Yahineze ...	0 5 0	4	1·028	−·448	·603	3·849	4·23	12·05	7·82	32·2	16	17	14
	2	Thuyeze ...	0 5 0	6	1·028	−·482	·514	3·280	4·22	12·61	8·39	32·2	10	11	14
	10	Zeygyo ...	...	7	1·028	−·380	·452	2·883	4·20	11·06	6·86	27·2	28	27	27
	33	Amyauktan ...	0 4 0	60	1·022	−·378	·504	3·212	4·14	10·96	6·82	26·1	29	27	30
Series 2 under 4 per cent. and 4 per cent.	36	Yahineze ...	0 5 0	2	1·024	−·403	·544	3·469	3·91	10·84	6·93	27·9	24	27	25
	6	Shore ...	...	...	1·025	−·445	·492	3·139	3·81	11·31	7·50	28·8	17	20	22
	24	North Town ...	0 5 0	9	1·022	−·378	·531	3·386	3·76	10·36	6·20	25·8	28	28	30
	17	East Town ...	0 5 0	5	1·026	−·430	·460	2·933	3·76	11·11	7·35	29·8	19	21	20
	27	Zeygyo ...	0 4 0	5	1·018	−·310	·447	2·849	3·76	9·21	5·45	21·8	40	42	41
	8	Nyaungbinze ...	0 5 0	8	1·029	−·480	·463	2·953	3·31	11·35	8·04	32·3	10	15	13
	23	North Town ...	0 5 0	5	1·020	−·378	·471	3·005	3·28	9·13	5·85	23·8	28	39	37
	9	Zeygyo ...	...	...	1·023	−·380	·393	2·505	3·24	9·32	6·58	26·2	28	30	29
	14	Do. ...	0 4 0	5	1·019	−·330	·362	2·310	3·20	8·91	5·71	23·2	37	40	40

Fat content between	12	Nyaungbinze ...	0 4 0 to 5 0	7	1·030	−·395	·367	2·322	3·20	6·25	5·05	23·2	35	37	37
	30	Zegyo ...	0 5 0	34	1·022	−·403	·529	3·873	3·19	9·30	6·11	25·2	24	34	31
	13	Do. ...	0 4 0	20	1·025	−·420	·419	2·672	3·17	10·25	7·08	28·2	20	25	24
	41	Do. ...	0 5 0	100	1·025	−·418	·546	3·483	3·12	10·44	7·32	28·1	21	23	24
	32	Shore ...	0 5 0	12	1·022	−·353	·455	2·904	3·11	9·16	6·05	25·1	33	37	31
	19	Mingalaze ...	0 5 0	6	1·023	−·380	·412	2·628	3·11	9·76	6·60	26·1	28	30	30
	34	Payagyi ...	0 4 0	1½	1·020	−·328	·512	3·264	3·07	8·70	5·63	23·1	38	41	37
	29	Zegyo ...	0 4 0	6	1·021	−·296	·463	2·985	3·01	9·01	6·00	24·0	42	37	35
Series 6. Fat content between 2 per cent. and 3 per cent.	42	Do. ...	0 5 0	40	1·031	−·633	·684	4·366	2·82	12·45	9·63	36·8	...	...	1
	22	East Town ...	0 5 0	5	1·027	−·403	·522	3·329	2·81	10·27	7·46	29·8	14	20	20
	11	Zegyo ...	...	...	1·019	−·315	·335	2·134	2·78	8·16	5·38	21·8	40	43	41
	15	Shop 1 ...	0 5 0	50	1·031	−·505	·521	3·324	2·72	11·48	8·76	33·7	6	6	9
	37	Nyaungbinze ...	0 4 0	5	1·039	−·663	·707	4·510	2·34	11·72	9·38	41·3	...	...	...
	21	East Town ...	0 6 0	6	1·027	−·438	·531	3·390	2·31	9·77	7·46	29·3	18	21	21
	18	Do. ...	0 5 0	...	1·023	−·370	·393	2·505	2·25	8·69	6·44	25·3	29	32	31
	26	Nyaungbinze ...	0 5 0	6	1·023	−·423	·482	3·075	2·18	8·70	6·52	25·2	20	31	21
Series 4. Fat content between 1 per cent. and 2 per cent.	3	Yahineze ...	0 5 0	...	1·023	−·392	·356	2·273	1·74	8·04	6·30	24·7	26	33	33
	31	Shore ...	0 5 0	7	1·031	−·508	·515	3·287	1·61	9·32	7·71	32·6	5	18	12
	16	Myatpayat ...	0 4 0	5	1·029	−·470	·413	2·635	1·58	9·42	7·84	30·6	21	17	17
Series 5. Fat content less than 1 per cent.	28	Zegyo ...	0 4 0	6	1·030	−·458	·428	2·731	·93	8·52	7·59	30·9	14	20	12
	25	Nyaungbinze ...	0 4 0	12	1·023	−·376	·531	3·386	·93	7·32	6·39	23·9	23	32	36
	20	Mingalaze ...	0 4 0	4	1·032	−·520	·488	3·113	·87	9·41	8·54	32·9	4	8	11
	7	Zegyo ...	0 4 0	...	1·025	−·415	·351	2·238	·62	7·32	6·70	25·6	22	29	31
	39	Mingalaze ...	0 4 0	6	1·025	−·408	·467	2·981	·61	7·15	6·54	26·6	23	31	28

Second series, fat between 3 per cent. and 4 per cent.

This is a large and therefore typical group. Every sample here has been watered, the added water ranging from 10 per cent. to 42 per cent. with average of 29 per cent.

In addition to watering some samples have been deprived of fat.

Samples 30, 41, and 34 contain less fat than proteid and in sample 29 fat and proteid are almost identical.

From the others cream has probably not been removed. They are simply samples of diluted milk.

Third series fat content between 2 and 3 per cent.

From this group 2 exceptional samples 42 and 37 must be considered separately. Their freezing points are lower than that of normal milk.

This is due to the fact that these milks are known to have been boiled and concentrated to remove cream.

The result has been verified in the laboratory where it was found that with moderate boiling the freezing point figures decrease almost propotionately to the extent of concentration.

That the boiling was effective in the removal of cream is shown by the abnormally high proteid fat ratio, and that the low freezing point figure is not due merely to addition of sugar, for instance, is made clear by the proteid content.

The remaining 6 samples have all been watered and all except No. 11 have been extensively deprived of fat.

It is noticeable in every case where much water has been added relatively less fat has been removed and *vice versâ*.

In the last 2 series we are obviously dealing with a bye product of ghee and cream manufacture rather than with milk.

The fat in the last samples is very low.

The mean of these 42 samples shows that average amount of water added is 21 per cent. *i.e.*, every 5 bottles of milk sold contain 1 bottle of added water. The case is however much worse than this becanse the milk has been further impoverished by removal of cream.

The 42 samples give an average fat content of 2·97 per cent. whilst from Table VI we know that pure Mandalay milk should contain 5·36 per cent., *i.e.*, fat content of the milk sold in the bazaar is on an average only about 56 per cent. of the fat content of pure milk.

As the fat is by far the most valuable constituent of milk, the milk sold to the public is worth just a trifle above half the price of pure milk.

7.—Comparison of milk adulteration in Mandalay and Poona.

7. It is important to know how adulteration here compares with practice in other towns. On the subject of milk adulteration in an Indian city only 1 paper based on a considerable number of analyses

has been found. This is a record by Dr. Mann on the Poona Milk Supply (Agricultural Journal of India, 1914).

Dr. Mann has taken 3·5 per cent. fat and 8·5 per cent. solids not fat (12 per cent., total solids) as the minimum figures for pure milk. He states that 90 per cent. of the samples of pure Poona milk would be well above these limits.

It is not stated however whether cream is ever removed by vendors before selling the milk nor is it clear whether watering was calculated on the basis of fat content, solids not fat or total solids.

Assuming that dilution has been calculated on solids not fat the Mandalay results show that reliable values can be obtained.

Dr. Mann found that in the worst Poona samples 100 parts of milk were diluted with 180—200 parts of water.

It is true that in Mandalay dilution to this extent is not found.

We have found several Mandalay samples containing 40 per cent. of added water. This means 60 parts of milk to 40 of water or expressed according to the Poona results 100 parts milk to 70 of water.

It has already been remarked however that the commercial value of milk depends very largely upon its fat content and therefore removal of fat is practically identical with dilution.

Looked at in this way the Mandalay figures are if anything worse than Poona.

For by mere dilution at Poona of 100 parts milk with 130—200 parts water the fat content would be reduced to $\frac{1}{2}$ or $\frac{1}{3}$ of the normal amount.

In Mandalay we found several samples in which, by removal of cream, the fat content had been reduced to $\frac{1}{5}$ of the normal amount which is practically equivalent to diluting 100 parts milk with 400 parts water.

Dr. Mann does not give a figure for average dilution.

In Mandalay it was found that the combined effect of cream removal and dilution brought the fat content of marketed milk down almost to half the normal amount, and this means practically 100 parts water to 100 parts milk. The Poona average is not likely to be worse than this.

There is however a very important distinction between the Poona and Mandalay conditions which requires attention. In Poona (taking pure milk at about 2 annas per lb.) the price of milk was found to vary almost exactly in proportion to its adulteration, *i.e.*, the purchasers knew enough about milk to be able to pay the correct price for quality obtained and on the whole no financial loss was incurred. In Mandalay on the other hand (as the figures show) the price is practically the same (1·4 annas per lb.) for all qualities from pure milk down to $\frac{1}{3}$ milk and $\frac{2}{3}$ water.

The public here has not troubled to distinguish between different qualities of milk, does not know the extent to which adulteration is practised, and is at the mercy of the vendors.

It would very greatly help matters if the public were made acquainted with these facts.

Until there is a desire to obtain better value for money spent on the part of the purchasers there is little prospect of improving the milk supply.

8.—Possible improvements.

To effect an improvement we require both a demand for and a supply of pure milk.

There seems little doubt that a demand would arise rapidly if the facts regarding adulteration were made known.

I recommend that this should be done. It could be effected by the issue of leaflets and occasional articles in the press, and by exhibits at certain popular gatherings.

To satisfy the demand for pure milk should be possible.

In this connection it is important to note that some pure milk comes on to the market at the normal price ruling for milk. (See Table VII, samples 4 and 5) It can therefore be produced at this price.

No doubt the margin of profit on its sale is at present small, but better yields and better marketing facilities would make a great difference to the profits obtainable. With a demand for better milk the price will go up unless a reliable and expanding source is available. There are already in existence a number of Co-operative Credit Societies in and in the neighbourhood of Mandalay, and the most satisfactory method of organising the milk-producers of the villages would be on co-operative lines.

At present the village milk is bought by dealers in the jungle at 2 annas a viss and is sold either pure or adulterated at 5 annas a viss in town.

It appears that while the conditions for cheap production are favourable the obstacles to cheap transport and marketing are very great. The latter can only be overcome by working on a larger scale. It may be concluded also that by facilitating transport production would be increased. I believe that if the figures were examined it would be found that a collecting service and sale depôts could be set up and connected on co-operative lines with every prospects of financial profit, provided that the Municipality were prepared to give certain facilities. The societies could easily ensure that the milk they offer for sale is pure. There is a reasonable prospect therefore of meeting by this means an increased demand for milk of good quality.

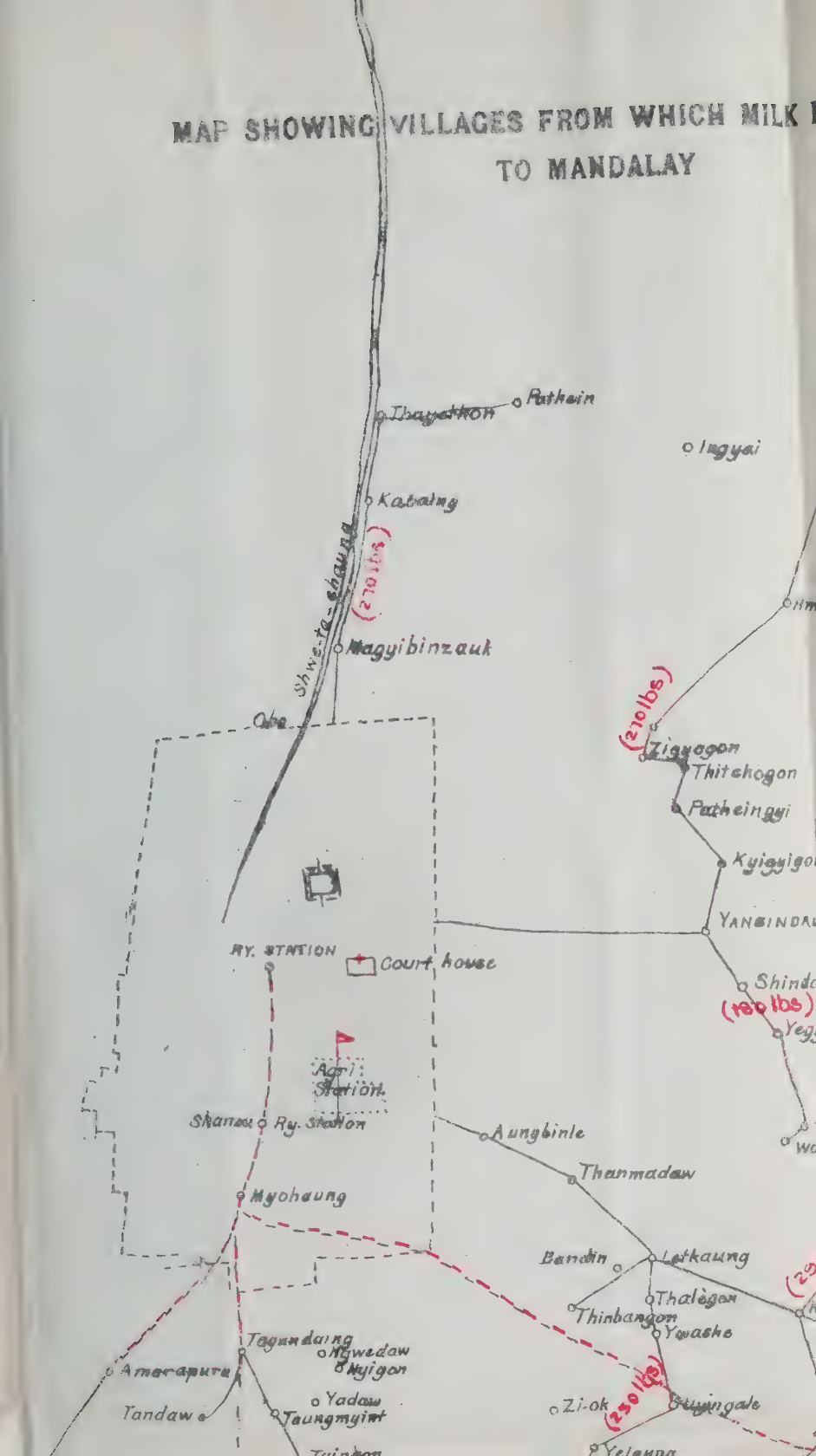
I recommend that the subject be examined by the Co-operative Department and brought to the notice of Agricultural Societies in the neighbourhood of Mandalay. The Agricul tural Department would of course give every assistance possible to the carrying out of any scheme.

There remains still the skimmed milk from the manufacture of ghee and cream to be considered. This will always be available and there is no objection whatever to its use or sale as such. At present according to the figures of Table VII it appears as and is paid for as ordinary milk.

Its sale at this excessive price will cease or be greatly restricted when the public has pure milk depôts to turn to.

F. J. WARTH,
Agricultural Chemist, Burma.

G.B.C.P.O.—No. 44, D. of A., 28-2-1917—550.


MAP SHOWING VILLAGES FROM WHICH MILK
TO MANDALAY
Thayekkon
Pathein
Ingyai
Kabaing
Shwe-ta-chaung
(210 lbs)
Magyibinzauk
Ohn
(210 lbs)
Zigyogon
Thitchogon
Patheingyi
Kyigyigo
YANGINDA
RY. STATION
Court house
Shind
(180 lbs)
Yeg
Agri. Station
Shanzu
Ry. Station
Aungbinle
Thanmadaw
Myohaung
Bandin
Letkaung
Thalegon
Thinbangon
Ywashe
Tagundaing
Ngwedaw
Nyigon
Amerapura
Yadaw
Tandaw
Taungmyint
Zi-ok
(230 lbs)
Yelaung

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Department of Agriculture, Burma

BULLETIN No. 15
1917

THE MANDALAY MILK SUPPLY

BY

F. J. WARTH, M.Sc.,

AGRICULTURAL CHEMIST, BURMA

RANGOON

OFFICE OF THE SUPDT., GOVERNMENT PRINTING, BURMA

1917

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Department of Agriculture, Burma

BULLETIN No. 16

1920

"THE 'GWABO' DISEASE OF PADDY"

BY

Messrs. E. THOMPSTONE, B.Sc.

AND

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UNIVERSITY OF
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1922

"GWABO" 1919-20.

A report by Messrs. E. Thompstone, Deputy Director of Agriculture, Northern Circle, Mandalay, and A. M. Sawyer, Assistant Botanist, Mandalay.

A.—Summary of previous information.

I. In 1911 a preliminary enquiry regarding the nature of Gwabo and its relation to local conditions was made.

The following year further observations were conducted on—

(*a*) The inheritance of Gwabo.

(*b*) The possibility of insects inducing it.

(*c*) The relation of weather conditions to the fertilization of paddy.

(*a*) *Inheritance of Gwabo.*—Sound and diseased grains with and without treatment by Copper Sulphate and Formalin, were sown, the resultant plants indicating that *gwabo was not inherited.*

(*b*) *Possibility of insects inducing Gwabo.*—The Assistant Entomologist, Burma, found that the following insects cause sterility :—

(1) *Paddy Stalk Borer* (Schoenobius bipunctifer, Wlk.) causes *complete sterility* by "boring into the upper part of the stalk which bears the panicle and destroying it completely before the grains are formed."

(2) *Rice Bug* (Leptocorisa varicornis) causes *partial sterility* by "sucking out individual grains in the 'milk' stage of development."

(*c*) *Relation of weather conditions to fertilization of paddy.*—The Assistant Botanist's and the Deputy Director of Agriculture's observations on this question are summarised below :

"Dewy mornings appear to be most favourable (for the opening of the paddy flower) and 'flowering' will be at its maximum height about 8 to 9 a.m. As the dew gradually disappears the flowers will be found to be opening rapidly but, as soon as the day begins to get very bright, dry and warm, no more glumes open and those already opened close up again—the stamens by this time being dried and shrivelled up."

"Pollination takes place before the glumes open, or at the moment of opening—seldom afterwards. At the moment they emerge from the glumes the outturns are found to be already open and pollen grains can generally be found on the stigmas." -(Agricultural Journal of India, Volume X, Part I, pages 50-51.)

Fertilization and the prevalence of Gwabo.—"Gwabo" is the Burmese name given to that condition of paddy indicated by empty husk without any grain enclosed. In some parts of Burma and in some seasons "Gwabo" is very prevalent—the writer has seen samples threshed with twelve to fifteen per cent. of empty husk. Although it is known that whole heads of unfilled grain may be the result of boring

grubs (Schoenobius bipunctifer) which are fairly common in some parts and that, as shown by Dr. Butler (*vide* " Diseases of Rice," Bulletin No. 34, Agricultural Research Institute, Pusa, pages 34—36) the fungus *Sclerotium Oryzae* may be the cause of considerable losses, yet these are not what is generally referred to as " Gwabo " nor can they be made to account for more than a small portion of the damage, which amounts to many lakhs of rupees annually. The presence of the borer grub is easily seen and the work of the fungus is not difficult to identify. The real " Gwabo " as mentioned here is that condition where the sterile grains are not found in whole heads or even in masses on one head but scattered throughout the panicle among the sound grains. The grains near the rachis are more generally affected than those on the ends of the branches. The ears are not always discoloured and there is no late tillering nor development of green sterile shoots nor discolouration of lower internodes to indicate the presence of the fungus. The husk is completely empty (except for the shrivelled stamens and ovary). It contains no badly developed grain as is sometimes the case after the work of the insect and the fungus there does not appear to have been any attempt at development.

" It appears to be quite possible that conditions of climate and atmospheric moisture may have some effect upon the fertilization of the ovules. Many intelligent Burman cultivators maintain that heavy rainfall at the time of flowering is the cause of this sterility and consequently after a season which is very wet at the time paddy is flowering " Gwabo " is prevalent. This is in accord with Hector's statement that " if the weather is wet and rainy at the time when the flowers should normally open, they may not open at all or, if they do, they often do not close again and a large percentage of such flowers, set no grain " (*vide* Memoirs Department of Agriculture in India Botanical Series, Vol. VI, No. 1, page 4). Other cultivators state that excessive irrigation has the same effect, whilst still others have similar theories connected with the wind.

" No evidence can at present be found indicating that there is greater proportion of empty husks in those varieties flowering here during the rains than in those flowering during the dry weather. In fact observations point in the other direction, *viz.* that the *Kaukkyi* crop—flowering in November-December—suffers the greatest proportion of loss. If, as is generally believed, climatic conditions do modify pollination or its effects the above appears to indicate that the varieties which habitually flower during the rainy season are in some way adapted for this purpose; but the *Kaukkyi* varieties, not being so adapted, when a wet spell occurs at the time of flowering, are unable to effect fertilisation of all the flowers." (*Vide* Agriculture Journal of India, Vol. X, Part I, pages 50—53.)

Observations made by the Assistant Botanist in the season 1916-17 on the opening of the flowers of Taungteikpan, a typical *Kaukkyi* paddy of Upper Burma showed that—

" (1) From seven to ten days are required for the opening of all the flowers on one panicle, reckoning from the splitting of the sheath to the blooming of the last spikelet.

(2) The greater number of flowers on a panicle open between the third and seventh days after the splitting of the sheath.

(3) The greater number of flowers open between 9 a.m. and a.m.

(4) It takes from 1½ to 13 minutes for the complete blooming a flower, *i.e.* for all the stamens which are destined to emerge to me out on the opening of the glumes.

(5) It takes ½ to 6½ minutes for a stamen to emerge, more than e stamen often emerging at one and the same time.

(6) Frequently, only 5 of the 6 stamens emerge, the sixth being t in when the glumes close back.

(7) The flower remains open, *i.e.* is exposed between the open- and the closing back of the glumes for 60 to 74 minutes.

(8) Directly the glumes reach the limit of divergence in the act opening, they begin to converge in the act of closing; so that the ning and the closing are but parts of one continuous and sustained rt (*vide* Annual Report for year ending June 1917, page 64).

II. In 1912 samples of paddy affected with *gwabo* were forwarded Dr. Butler for examination; and in 1913, at our request, he ted Burma to investigate the subject locally. The results of his est gations have been summarised by him in the following terms:—

"The commonest condition found in *gwabo* was that in which the e ear with its stalk for a variable distance was found withered, e in colour, light and with all or nearly all the grains empty. This found to be due to the attack of a boring grub in the stem, usually he upper internodes. I was informed by Mr. Shroff, Entomolo- Assistant to the Burma Department of Agriculture, that this ct is probably *Schoenobius bipunctifer*. One variety of attack is sed by the same or a different grub eating transversely round the e of the stem so as to cause a "ringing" wound, visible from the ide as a discoloured band. If the attack is late some of the grains m set and a partially sterile ear results.

"In other cases, the ear was found less completely sterile, with y half formed grains, the grains being brown in colour or spotted wn and straw coloured. Most of these cases were due to the ck of a larger borer in one of the lowest internodes near the ground l. This, Mr. Shroff said, was possibly *Nonagria*. Plants thus cked seem able to produce ears but not to mature any but a limite. mber of grains.

"In a third set of cases the stem was sound but individual grains a been punctured and sucked and eaten out. This form of insect ck, while not causing such obvious damage as the stem borers, at yet be responsible for a considerable loss of grain.

"In almost all these cases, the affected ears were invaded by aprophytic and weekly parasitic moulds. Still it may safely be said *the bulk of the damage known as* "gwabo" *in Lower Burma is ed by insect pests of paddy.*

"In Upper Burma the same insect pests were found but, in dition, a considerable number of cases were encountered in which race of insect injury could be detected but which nevertheless had undue proportion of light or empty grains. The ears in these cases e not discoloured in any way, the glumes of the light grains were onal and, except in late cases, moulds were not present within them

to any appreciate extent. In fact, considerable difficulty w experienced in deciding, without examination of the individual grai whether any particular plant was bearing normally or was partial sterile, until it was noticed that this form of sterility was invariat accompanied by excessive late tillering and the development of gre sterile shoots from the basal nodes of the stalks. As the crop w nearly ripe, it was easy to pick out such plants as bore these gre shoots and every case it was found that the ears were not maturing full proportion of their grain. It was further noticed that when o plant in a clump bore these late shoots, all the other plants in th clump were as a rule similarly affected and every ear had a considerat number, *often up to* 50 *per cent. or more*, of light grains.

"An examination of these plants showed that the base of t stem was usually discoloured at the lowest distinct internode or t next one or two above. At this point fungus hyphae were fou penetrating the stem tissues and also, sometimes in considera quantity, in the cavity of the pith."

"The lower leaf sheaths were also found invaded by simil hyphae and were rotten and crumbled to shreds readily. Within t pith cavity, and also in greater amount in the rotting sheaths, lar numbers of minute, round, shiny sclerotia were found, embedded and obviously arising from the hyphae."

"Mr. Shaw, Supernumerary Mycologist, found that the fung was *Sclerotium Oryzae, Catt*, a rice parasite first described in Ita in 1879 but concerning the life history and parasitism of which n much is known."

"This hitherto unsuspected disease of rice is widely distribut in India. The amount of damage caused by it is, as yet, unknow *In Burma it does not appear to be responsible for any but a sma part of the losses caused by* "gwabo*"

In his article "A Sclerotial Disease of Rice" in Vol. VI Memoi of the Department of Agriculture, India, pages 11—21, Dr. Shaw refe to the fungus in the following terms: "The fungus is known as *Scler tium Oryzae, Catt.*, and was first described by Cattaneo, in 1879, the cause of extensive damage to the rice crop in Novara and Lombard In December 1912 material was obtained from localities as wide separate as Mandalay, Samalkota, and Pusa; the external sympton of disease were in all cases essentially the same. Infected plants c usually be distinguished from their healthy neighbours by the phenom non of "tillering," that is to say, the development of fresh green shoo from adventitious buds at the base of the infected culm. The infect culm gradually turns yellow and dies; any grain which it bea is light and poorly developed, in fact, there is usually nothing with the glumes. The most distinctive feature, indeed, the easiest means detecting infected plants in the field is the "tillering" from the ba In Pusa the disease does not make its appearance until the paddy cr is fairly well advanced; hence, even supposing that the fresh shoo remain free from the fungus, an unlikely event, there is no possibility their producing any grain. It is the loss of grain which constitutes t most serious damage due to this fungus. In Burma the disease is o

* (*Vide* Bulletin (Pusa) No. 34, 1913, "Disease of Rice" (pages 34—36).

of the causes producing the condition known as "*gwabo*"; as, however a number of insect diseases of paddy are included under this name, *it is difficult to ascertain the precise amount of damage due to the fungus.* The collective damage done by the combined insect and fungus attack is stated to run into hundreds of lakhs of rupees annually."

"Against a parasite such as *Sclerotium Oryzae* it is difficult to see what remedial measures can be employed with success. The sclerotia of the fungus undoubtedly perennate in the soil, where, under favourable conditions, they germinate and produce a mycelium which attacks the paddy crop. Probably the breeding of resistant varieties is the only method by which any permanent resistance could be made in the case of a field crop such as rice. Fortunately the damage done in India at present does not appear to be sufficient to bring this question within practical consideration.

B.—Investigation in 1919-20.

The proceedings of the Conference of the Agricultural Department held in Maymyo on the 24th May 1919 contains the following minute :—

"7. From a discussion it appears that the term "*gwabo*" covers several distinct losses suffered by the paddy cultivator. It was agreed that the Deputy Director of Agriculture, Northern Circle, and the Assistant Botanist, determine this year on a specific number of plots on Mandalay Farm, the amount of empty glumes caused by—

(*a*) Insect attack ;
(*b*) Sclerotial disease ;
(*c*) Unfavourable weather at flowering, and report the results at next Conference in 1920.

In the season 1919-20, *gwabo* was prevalent on the Mandalay Farm to a more marked extent than it was in previous years. There was a noticeable quantity of it in every plot and on every kind of paddy. The season was, therefore, specially favourable for an investigation into the causes producing it. The enquiry was conducted over 17 plots—2 of early-flowering varieties of the Kauk-yin class of paddy represented by Japanese 'Hoire" and 'Hoito," 5 of the Kauk-lat class flowering in mid-season and typified by "Kalagyi" and 10 of the late flowering Kaukkyi class represented by "Taungteikpan" and "Ngasein." Many fields were searched throughout for diseased clumps and upwards of 20,000 tillers were dissected in the laboratory and more than 6,000,000 grains were examined, separated into good and bad and counted.

2. *Extent of loss due to gwabo.*—Statement I summarises the results of an examination of the crops to determine the total amount of damage caused by *gwabo*. Actual countings on the field and in the laboratory showed that the average percentage of clumps affected was 48·10 and of unsound grain in these clums 41·87. By calculation this shows that whilst the mean reduction of the total crop was 19·87 per cent. the actual reduction was in one case as low as 1½ and, at the opposite extreme, as high as 51 per cent.

3. *Causes of gwabo.*—Statements II and III show the results obtained in the laboratory, after careful dissection and examination, of the tillers affected and of the grain damaged by the identified agents causing *gwabo*. These agents were two only—

(*a*) *the paddy Stem Borer*—the larva of a moth (*Schoenobius bipunctifor*).

(*b*) *Sclerotium Oryzae*—a soil fungus of the Rhizoctonia group with "obscure symptoms and widely prevalent in practically all the important rice growing areas in India" (Butler).

The figures indicate that practically the whole of the damage is caused by one or other of these two agents. Under the heading of "Undetermined" we have shown the relatively small percentage of tillers, in which *gwabo* appeared, which could not be traced to one or other of these two agents; but since difficulty was often exprienced in determining the presence of the agent and as no other agent could be discovered, it is probable that a good part at least of this undetermined damage was due to either to borer or the Sclerotium.

Statements II and III also show that whilst the fungus is responsible for a very material part of the damage, the borer is responsible for 2½ times as much. The borer should therefore be recognised as by far the more destructive agent.

Statement IV indicates that the stem borer becomes more prevalent in those varieties which are planted later in the season, whilst the sclerotial fungus shows the opposite tendency. Yet, on the other hand, within the same variety (Statements II and III) the sclerotium disease would appear to *increase* with the lateness of planting. The borer seems to be equally prevalent whether the crop is planted early or late. It must be remembered however, the observations over one season do not justify definite conclusions being drawn either on the relations of the pests to varieties or to time of planting.

Observations regarded in Statements II and III give very little indication of the climatic conditions which favour either of these pests and before any conclusion whatever can be drawn such observations will have to be extended over a number of years.

Observations in the field.—Gwabo due to sclerotium was remarked by the Deputy Director of Agriculture, Northern Circle, to occur generally in patches and this was afterwards observed by the Assistant Botanist and verified by extensive and careful examination. The damage due to the borer, on the other hand, is dispersed all over the crops the clumps affected being scattered throughout.

2. Sclerotial disease is more prevalent near the borders of the fields.

I.—*Statement showing loss, per cent., of crop due to* Gwabo, 1919-20.

Class of Paddy.	Name and Plot No.	Season of flowering.	Percentage of clumps affected.	Percentage of sound grains in the affected clumps.	Percentage of unsound grains in the affected clumps.	Reduction of total crop, per cent.	Remarks.
Kauk-yin	Japanese, "Hoire" ..	26-9-19— 1-10-19	9·26	69·42	30·58	2·83	
	Do. "Hoito" ...	27-9-19— 2-10-19	4·47	67·80	32·20	1·44	
Kauk-lat	Kalagyi, 4 ...	1-11-19— 6-11-19	39·00	51·04	48·96	19·09	
	Do. 5 ...	5-11-19—12-11-19	48·00	65·08	34·92	16·75	
	Do. 6 ...	12-11-19—18-11-19	49·00	66·16	33·84	16·49	
	Do. 7 ...	18-11-19— 8-12-19	53·00	55·18	44·82	23·74	
	Do. 8 ...	15-12-19— 1-1-20	61·00	15·94	84·06	51·27	
Kyauk-kyi	Taungteikpan, 3 ...	5-11-19— 1-11-19	40·00	56·20	43·80	17·51	
	Do. 4	5-11-19—13-11-19	50·00	61·80	38·11	19·05	
	Do. 5 ...	9-11-19—15-11-19	51·00	69·08	30·92	17·03	
	Do. 6 ...	17-11-19—23-11-19	56·00	71·40	28·60	16·02	
	Do. 7 ..	27-11-19— 2-12-19	54·00	52·90	47·10	25·42	
	Ngasein, 3 ...	13-11-19—20-11-19	55·00	56·01	43·99	24·18	
	Do. 4 ...	11-11-19—20-11-19	50·00	55·65	44·35	22·17	
	Do. 5 ...	11-11-19—18-11- 9	46·00	59·38	40·62	18·69	
	Do. 6 ...	15-11-19—22-11-19	50·00	63·09	36·91	18·45	
	Do. 7 ...	27-11-19— 8-12-19	58·00	51·91	48·09	27·89	
		Mean	48·10	58·12	41·87	19·87	

II.—*Statement showing loss, per cent., of crop (as indicated by unsound tillers), apportioned to the agents producing* Gwabo, 1919-20.

Class of Paddy.	Name and Plot No.	Climatic conditions at time of flowering. Rainfall (inches).	Mean Temp. (Deg. Fah.)	Special features.	Percentage of unsound tillers caused by Stem Borer (Schoenobius bipunctifer).	Sclerotium oryzae.	Undetermined.	Percentage of unsound tillers in 100 affected clumps.
Kauk-yin.	Japanese "Hoire"	3·96	88·25	Heavy rain for a third of the period; hot throughout.	11·71	31·23	9·82	60·05
	Do. "Hoito"	3·96	88·55	Do.	21·40	16·75	11·16	49·31
Kauk-lat	Kalagyi, 4	...	83·50	Heavy dew for one-third of period; hot; windy	49·34	14·77	10·02	74·13
	Do. 5	...	83·13	Do.	47·22	14·35	2·31	63·88
	Do. 6	0·84	80·36	Light rain for half the period; dew; mist; cold; dull	46·80	22·50	0·76	70·06
	Do. 7	0·45	77·88	Light rain for one-tenth of period; dew; mist; warm and still.	27·72	45·90	...	73·62
	Do. 8	0·15	69·86	Do. for one-eighteenth of period; do.	32·76	22·22	...	54·98
Kauk-kyi.	Taungteikpan, 3	...	83·14	Heavy dew for half the period; cloudy and hot	61·98	4·98	0·87	67·83
	Do. 4	...	83·16	Do.	76·50	0·12	...	76·62
	Do. 5	0·47	83·29	Rain for a day at end of period; dew and mist; cloudy and hot.	56·65	2·10	...	58·75
	Do. 6	0·48	78·07	Rain in early part of period; heavy dew and mist; hot.	49·78	9·14	0·84	59·76
	Do. 7		78·00	Dewy; cloudy, still and hot	34·91	13·28	...	48·19
	Ngasein, 3	0·97	79·58	Rain and cold for half the period; cloud; mist; windy; dull and hot for remaining half.	33·86	7·81	19·43	61·10
	Do 4	0·97	80·20	Do.	50·00	17·46	0·91	68·37
	Do. 5	0·84	80·63	Rain for half the period; cloud; mist; wind ..	36·29	16·29	...	52·58
	Do. 6	0·97	78·00	Rain for half the period; heavy dew and mist; dull and cold; bright and hot for remaining half.	25·38	30·76	...	56·14
	Do. 7	...	77·38	Dew; cloud; wind; hot throughout	66·00	7·69	...	73·69
				Mean ...	42·88	16·31	3·30	65·23

III.—*Statement showing loss, per cent., of crop (as indicated by unsound grains), apportioned to the agents producing* Gwabo, 1919-20.

Class of Paddy.	Name and Plot No.	Climatic conditions at time of flowering.			Percentage of unsound grains in affected clumps caused by—			Percentage of unsound grains in the affected clumps.
		Rainfall (inches).	Mean Temp. (Deg. Fahr.)	Special features.	Stem Borer (Schoenolius bi-punctifer).	Sclerotium oryzæ.	Undetermined agents.	
Kauk-yin.	Japanese "Hoire"	3·96	88·25	Heavy rain for a third of the poriod, hot throughout.	7·96	20·46	2·16	30·58
	Do. "Hoito"	3·96	88·55	Do.	19·98	15·12	4·10	32·20
Kauk-lat	Kala-gyi 4	...	83·50	Heavy dew for one-third of period; hot; windy	34·94	10·99	3·03	48·96
	Do. 5	...	83·13	Do.	27·05	7·52	0·35	34·92
	Do. 6	0·84	80·36	Light rain for half the period; dew; mist; cold; dull	18·71	14·99	0·14	33·84
	Do. 7	0·45	77·88	Light rain for one-tenth of period; dew; mist; warm and still.	22·73	22·09	...	44·82
	Do. 3	0·15	69·86	Light rain for one-eighteenth of period; do.	57·71	26·35	..	84·06
	Taungteikpan,		83·14	Heavy dew for half the period; cloudy and hot ...	38·59	4·93	0·28	43·80
	Do. 4	..	83·16	Do.	37·91	0·20	...	38·11
	Do. 5	0·47	83·29	Rain for a day at end of period; dew; mist; cloudy and hot.	21·21	9·71	..	30·92
	Do. 6	0·48	78·07	Rain in early part of period; heavy dew and mist; hot.	23·42	4·92	0·26	28·60
	Do. 7	...	78·00	Dew, cloudy, still and hot	36·02	11·08	...	47·10
Kauk-kyi.	Ngasein 3	0·97	79·56	Rain and cold for half the period; cloud; mist; windy; dull and hot for remaining half.	29 50	7·86	6·63	43·99
	Do. 4	0·97	80·20	Do.	33·43	10·67	0·25	44·35
	Do. 5	0·84	80·63	Rain for half the period; cloud; mist; wind ...	29·89	10·73	...	40·62
	Do. 6	0·97	78·06	Rain for half the period; heavy dew and mist; dull and cold; bright and hot for remaining half.	19·31	17·60	...	36·91
	Do. 7	...	77·38	Dew; cloud; wind; hot throughout.	38·71	9·38	...	48·09
				Mean ...	28·71	12·03	1·01	41·87

IV.—*Statement showing extent of prevalence of* Gwabo *in relation to varieties examined* 1919-20.

Agent causing *Gwabo*.	Damage done as revealed by percentage of unsound tillers (Statement II).				Damage done as revealed by percentage of unsound grant (Statement III).			
	Kauk-yin	Kauk-lat	Kauk-kyi		Kauk-yin	Kauk-lat	Kauk-kyi	
	Japanese	Kalagyi	Ngasein	Taungteikpan	Japanese	Kalagyi	Ngasein	Taungteikpan
Stem-borer ...	16·55	40·77	42·77	55·96	10·47	32·23	30·17	31·43
Sclerotium ...	23·99	23·99	16·00	5·92	17·79	16·39	11·25	6·18

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BY

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AND

A. M. SAWYER.

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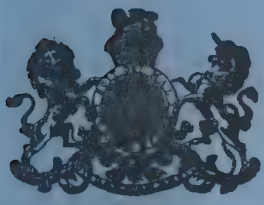

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FOREWORD

THE instructions given in this leaflet are meant to help the eginner to start bee-keeping with the locally available Indian Bees. hose who want fuller and detailed information regarding bees are ecommended to read Pusa Bulletin No. 46 on Bee-keeping, avail-ble from the Director of the Agricultural Research Institute, Pusa, rice 14 annas. The Assistant Entomologist, Burma, Mandalay, ill be glad to render any help he can to all enquirers. The ustrations in this leaflet are copied or adapted from Pusa Bulletin o. 46.

INSTRUCTIONS ON BEE-KEEPING.

The Bee-Colony.

Honey-bees live in large colonies. The place where the colonies live is known as their hive and they build combs there. The combs, as we all know, hang downwards and have a double series of well-like cells in horizontal position with their mouths opening in opposite directions. The cells of the comb serve as store-houses for honey as well as cradles for the young, usually called the "brood." If the bees are made to move away from the combs or the combs cut off, we usually find the cells in the upper part filled with honey and those in the lower part containing the brood. The brood or early stages of the bee are exactly like those of ordinary wasps. The mother bee lays small tubular white eggs, one in each cell. White, soft-bodied, wormlike grubs hatch from these eggs, are fed by the bees and grow and then go into a sleeping stage. The bees, as we see them, emerge from this sleeping stage and take their place by the side of the older bees in the colony.

The bees in the colony sit clustering over and entirely covering the combs, thus keeping the brood warm. Some of them are found constantly going out of and coming into the hive throughout the day. They do not fly at night and in foggy weather or when it rains. The members constituting the colony are the mother bee known as the "queen," a large number of working bees called "workers" and some male bees called "drones." There is a single queen in the colony and her only function is to lay eggs. Bees develop from these eggs in the way described above. The queen lives for about three years. The workers perform all work necessary for the colony, such as building combs, nursing the young, collecting food, keeping the hive clean and guarding it against enemies. Therefore the larger the number of workers present the better the condition of the colony in all respects. But they do not live for more than about three to six months. Therefore in order to replace those which die it is necessary to rear some young throughout the year, and this is what actually takes place. When food is available in abundance, rearing of the young is carried out on a very large scale and necessarily the number of bees in the colony increases rapidly. Food is available in large quantities, once in Autumn (about September—November) and again in Spring (about February to April), and these seasons are known as seasons of honey-flow. In hill-stations the Autumn honey-flow is more important than the Spring one, while in the plains the Spring honey-flow is more important than the Autumn one. When in these seasons the bees in a colony have increased sufficiently so as to feel a little overcrowded, they usually divide themselves to form new colonies. About half of them issue out of the hive for this purpose with the reigning queen and go and establish a colony elsewhere. This is known as swarming. Provision is made for the birth of a new queen in the old colony which thus goes on as before. The services of the drone are required to fertilize the new queen. As the drones help in no work of the colony and in fact live on the store of honey gathered by the workers, being incapable of

procuring their own food, their presence in the colony is tolerated only in the seasons of honey-flow. No drone is generally found at other times of the year.

Products of Honey Bees.

People rob the bees of their combs and squeeze out the honey stored in these combs. Where do the bees get this honey from? Most plants, such as grasses, weeds and trees secrete in minute quantities a sugary liquid called nectar in their flowers. Honey Bees collect these minute drops from the flowers principally for use as food for themselves and store the surplus in their combs in the form of honey for future use. This is why we find many bees always flying between their hive and the fields. They go up to a distance of about two miles all round their hive to collect nectar. Surplus is available only in the honey-flow season to be stored in the combs and in large quantities only in the time of the important honey-flow of the locality.

The combs from which the honey has been squeezed out are melted and yield the well known bees-wax. From where do the bees get this wax to build their combs with? They secrete it from their body through special organs called wax plates situated on the under surface of their body and build the comb by moulding this wax with their mouths.

Besides yielding honey and bees-wax, the bees perform another very useful function to benefit growers of various crops and fruits. While visiting the flowers for nectar they also collect pollen from them for use as food for their young ones. This pollen is the fertilizing element of flowers. As they go from flower to flower for nectar they mechanically distribute the fertilizing element among the flowers and thus help in the setting of fruits. There are many kinds of plants which do not produce any fruits unless their flowers are visited by bees.

Keeping Honey Bees.

It is possible to keep bees and get honey from them without killing or causing them inconvenience and without breaking or squeezing their combs. For this purpose they are made to build combs and live in artificial hives which can be kept in the garden or in the verandah of the house. The hives can be opened whenever one wants to see what the bees are doing. When honey is stored it can be taken out of the combs in the purest condition and the combs given back to the bees to fill again.

Which Bee to keep.

In this country four kinds of honey bees occur :—

(1) The first is the Rock Bee, colonies of which build huge single combs, sometimes about 4 or 5 feet in diameter, in open places such as faces of rocks, branches of large trees in forests or walls of buildings.

(2) The second is the Indian Bee, colonies of which always build combs in closed covered situations such as cavities in the ground, walls or tree-trunks and unused boxes or tins.

(3) The third is the Little Bee, colonies of which build small single combs in open situation, in bushes, under eaves of huts and cornices of buildings, behind doors and windows, in fuel stacks and in various similar places.

(4) The fourth is the Dammar Bee. It is not a true Honey Bee but is included here because its colonies gather small quantities of honey which is collected by people for medicinal purposes. These colonies live in hollow walls or tree trunks and build their combs not with wax but with a resinous substance known as "*Pwe-nyet*." The combs usually extend beyond the opening of the hollow in the form of a funnel.

Out of the above four kinds only the second, *i.e.* the Indian Bee, is capable of being kept in artificial hives. The Dammar Bee which, too, lives in closed situations like the Indian Bee is much smaller than house-flies, while the Indian Bee is much bigger than house-flies and has yellow bands on the body. Also the Indian Bee always builds several combs side by side. Therefore no mistake can be made about the kind of Honey Bee one should look for in order to keep in artificial hives.

Frames for Combs.

For keeping in artificial hives the bees are made to build combs in movable wooden bar frames shown in figure 1 in which measurements are given. These frames are made with strips of deal wood $\frac{7}{8}$ inch wide; the upper bar is $\frac{3}{8}$ inch thick and the lower and the side bars $\frac{1}{4}$ inch thick.

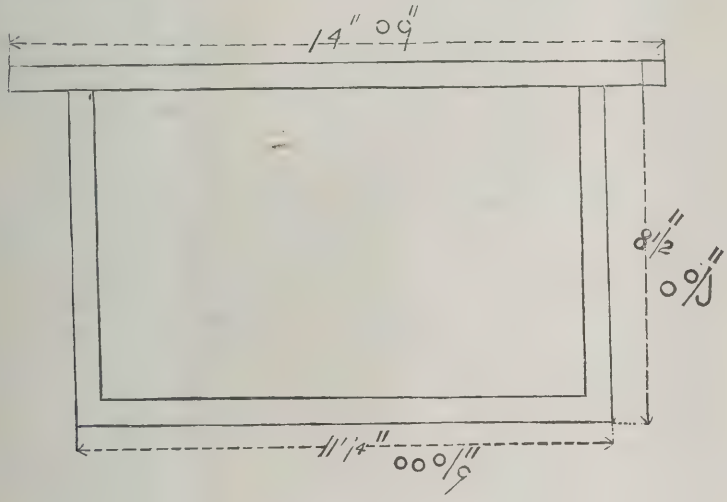

Figure 1.—Bar-frame.

One dozen frames are ordinarily sufficient for each hive. The frames have to be kept parallel and at regular distances in the hive. This is done by putting two nails one near each end on one side of the upper bar of the frame so that the nails project $\frac{1}{4}$ to $\frac{5}{8}$ inch out of the bar. Tin metal ends are used for this purpose but nails will ordinarily do.

Comb-fixers.

Each frame should have two comb-fixers which may be made with copper or iron wire bent with pliers or of thin strips of wood into

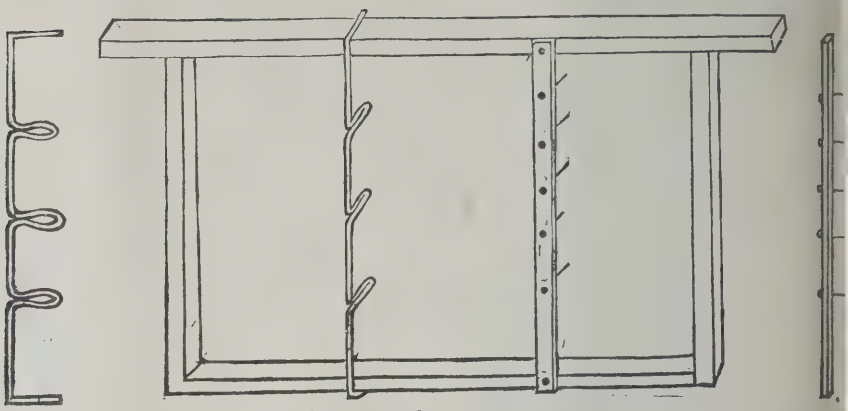

Figure 2.—Comb-fixers.

which nails are fixed. How the comb-fixers are attached to the frames is shown in the figure.

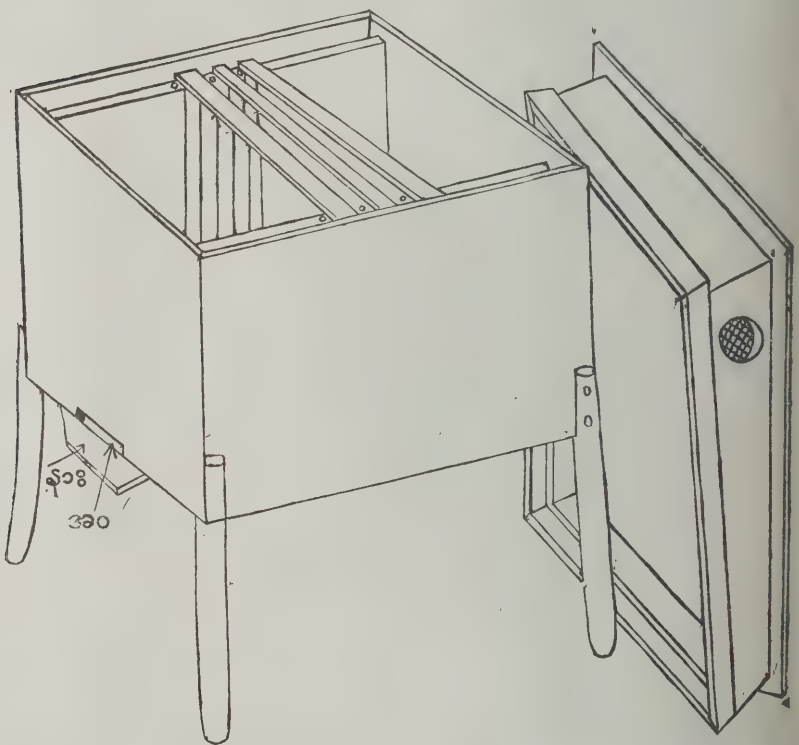

Figure 3.—Kerosen -box Hive, open, with 3 frames in place. ১২৪—Landing-place. ৩৩০—Entrance.

The Hive.

A cheap workable hive can be made from an ordinary kerosene packing case by adding a wall inside along each of the longer sides and four legs as shown in figure 3. The frames of combs rest on these inner walls which are 8⅓ inches high from the floor of the hive and 12¼ inches apart. A hole is made at one end near the floor to serve as entrance and a strip of wood added to serve as alighting board for the bees. The cover is made sloping and if not rain-proof protected with a sheet of old kerosene tin to prevent rain water. It has two holes protected with wire-gauze for ventilation. Such a hive complete with cover is shown in figure 4.

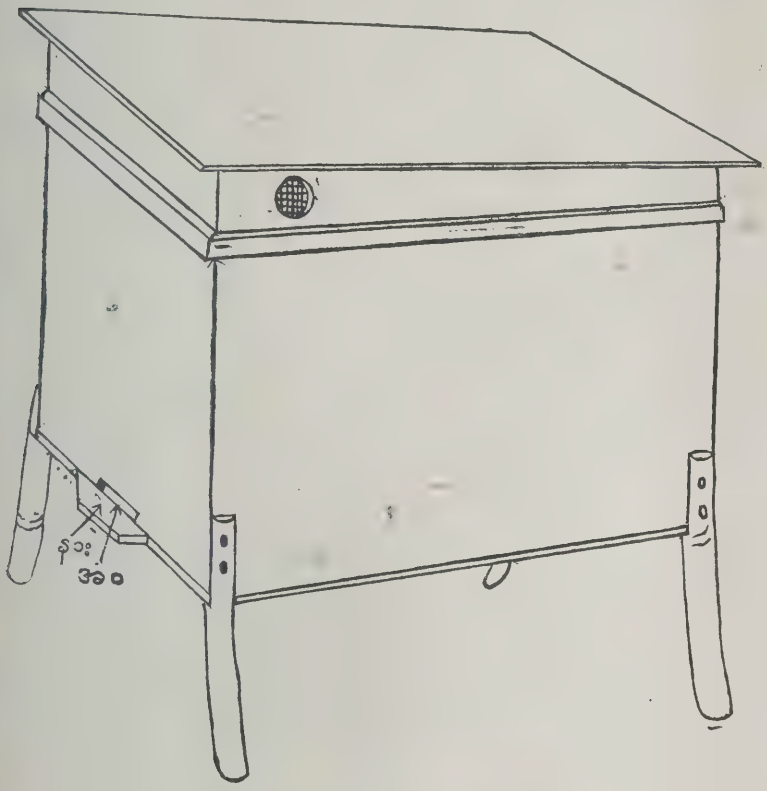

Figure 4.—Kerosene-box Hive, closed.

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Figure 5 shows a good hive made with deal wood ½ inch thick.

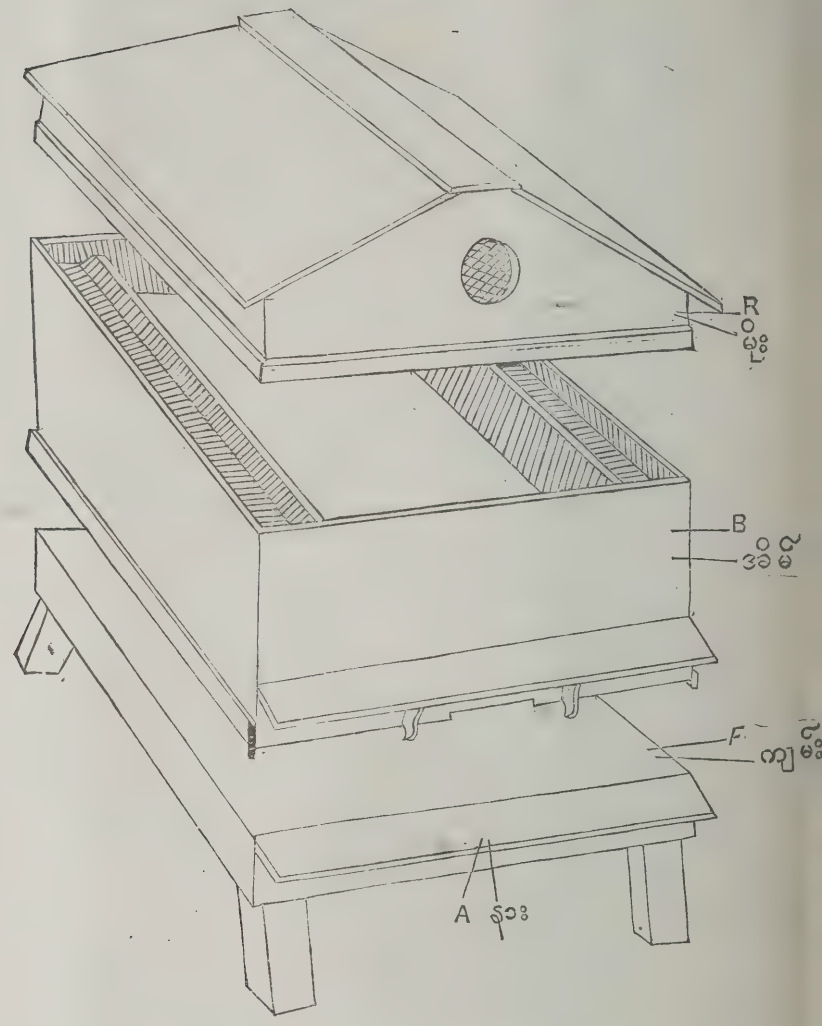

Figure 5.—Hive Roof (R). Hive Chamber (B) and Floor-board (F) shown separately. They fit into one another.

The floor-board, hive chamber and roof are shown separately.

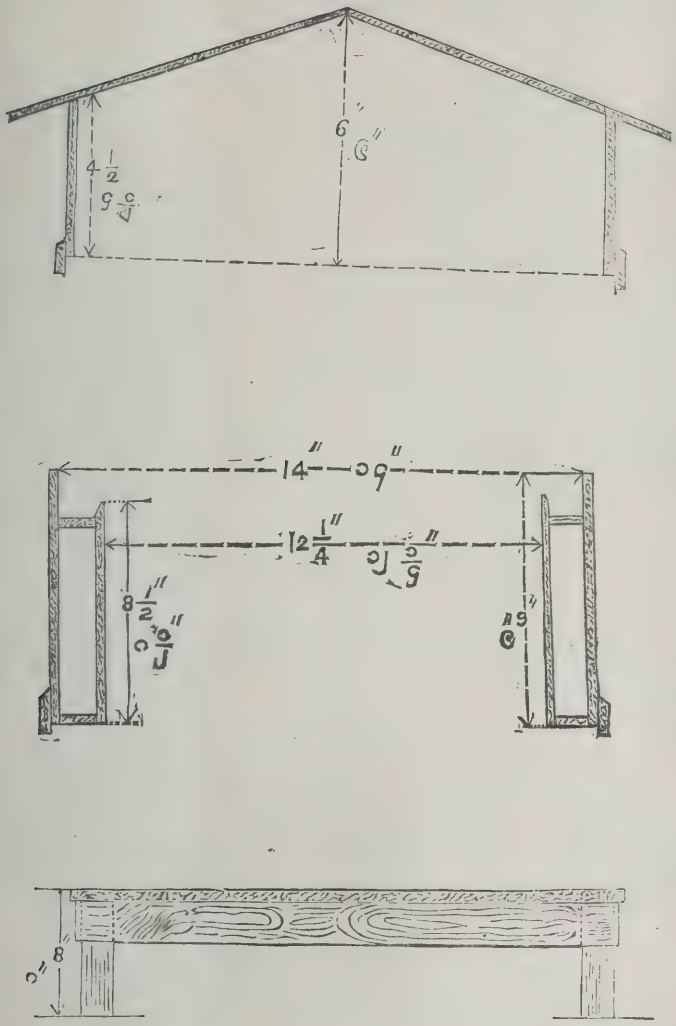

Figure 6.—Measurements of hive shown in Figure 5 in cross section from side to side.

The measurements are shown in figure 6 in cross section. The inside measurement of the hive chamber from front to back should be 17 inches. The hive is painted white on the outside.

Division-board or Screen.

When the combs occupied by the bees living in the hive do not fill the hive, they are pushed towards the entrance and the wooden screen shown in figure 7 is placed behind them thus—affording the

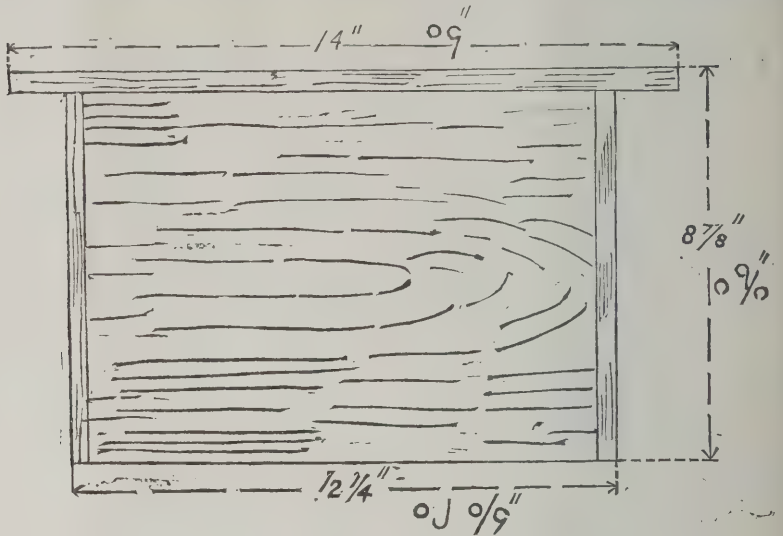

Figure 7.—Division-board or screen.

bees a completely enclosed chamber. This screen is prepared with an ordinary wooden board about half an inch thick. Each hive should have one such screen.

Quilts.

The combs in the hive are covered with a piece of gunny cloth or old carpet, blanket or oil-cloth, cut to the size of the inside measurement of the hive. This is called a quilt. In winter several folds of quilts may be necessary to keep the bees warm. In the hot weather only one sheet may be sufficient.

The Bee-keeper's Knife.

The blade is about six inches long and both the edges as well as the tip are sharpened and may be used for cutting. One such knife is sufficient and it can be made by local blacksmiths.

Figure 8.—Bee-keeper's Knife.

It is like the mason's trowel and is shown in figure 8.

Manipulating Bees.

Precautions in Manipulation.—It is the sting which deters people om approaching bees. The chief precaution against the sting is to pproach them very slowly and move the hands, body or other parts of ie body or appliances used, slowly and to open the hive and handle ie frames slowly and without jarring. Quick movements, jarring

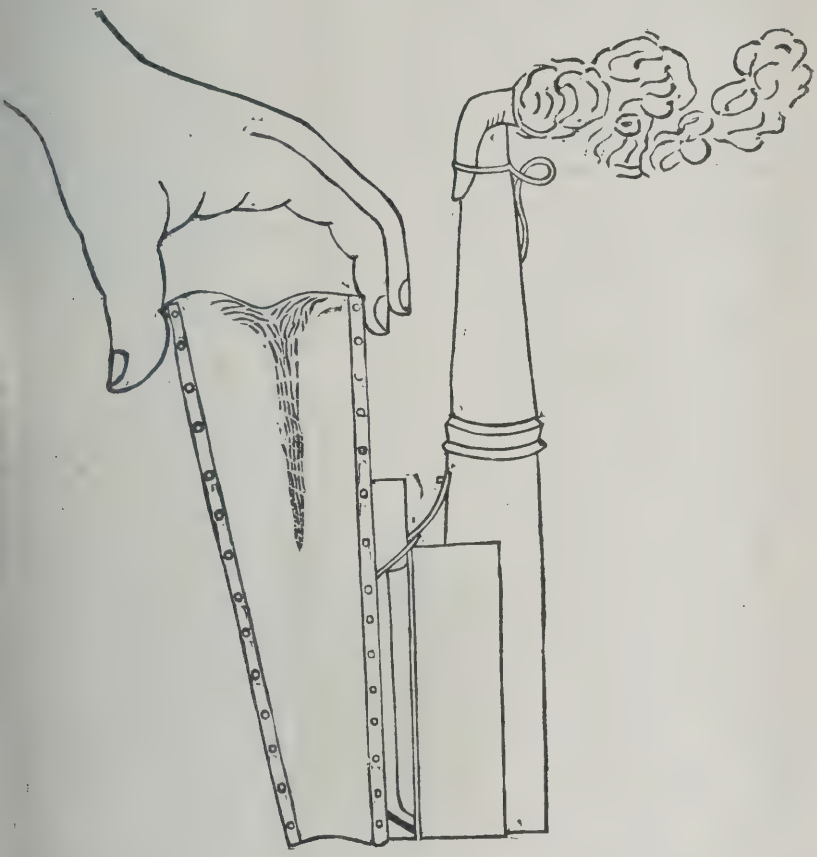

Figure 11.—Burgham Smoker.

ise and breathing or blowing hard against them, irritate them very uch. The smell of a crushed bee and also of a sting irritates them. herefore avoid crushing a bee. If a sting has been received and ngs are frequently received in bad manipulation it is better to walk ay slowly to a little distance, remove the sting and blow smoke on te part stung to hide the smell.

Gloves and Veil.—It is better to be provided against the sting. When angry the bees fly at once at the face. Therefore a veil can be used as shown in figures 9 and 10. The veil is made by sewing a piece of mosquito netting and the portion in front of the eyes should be dyed black for distinct vision. Similarly the hands can be protected by gloves (Figure 9).

Subduing Bees.—Bees have a dislike for or are rather frightened at smoke or any strong odour, such as that of carbolic acid. When frightened they fill themselves with honey and when so filled show hardly any inclination to sting and remain quiet. Smoke of burning rags or wood or mild tobacco may be blown on them. For smoking bees a special smoker (Figure 11) is manufactured and sold.

How to procure Bees and make a start.

Colonies of the Indian Bee can be procured in the following three different ways :—

(1) By means of decoy hives. Melted bees-wax is applied to the underside of the upper bars of the frames and these frames are arranged in the hive near the entrance and closed up with division board and quilt and cover. Thus arranged the hive is left in a shaded place. Frequently colonies come and occupy these hives. The decoy hives should be placed out in September and March—April in hill-stations and about December in the plains.

(2) By capturing swarms and hiving them. In the swarming seasons stray swarms are frequently found to come and settle on branches of trees, walls and other open places. If the place be accessible, the swarm can be captured in the following manner :—

Take a wooden or cardboard box about 9 inches by 9 inches and 6 inches deep with one side open. Hold the box open side down just over the cluster of bees or rather touching the cluster and apply smoke gently to the bees from below. The bees will slowly crawl into the box which can then be taken and placed inside the hive arranged as in (1), the screen board and some frames being removed for the purpose. The box with the bees should be placed with its open end turned towards the frames and touching the nearest one and if the bottom and sides of the box are drummed with a stick the bees will gradually leave it and occupy the frames. If the box into which the swarm has been driven is too big to be accommodated in the hive, the quilt may be turned over and some of the frames moved towards the back. The entire swarm is jerked down the gap thus produced and the frames drawn forward and the quilt turned down quickly. When a swarm has settled on a branch it can be jerked down at once into the hive in this manner by giving a hard and sharp blow on the branch. Before hiving the swarms in this manner the bees may be treated to sugar syrup which is simply sprinkled on the cluster and the bees will be found to lick it up from each other's body.

Newly hived swarms are better fed with sugar syrup for two or three days. The syrup is placed in a saucer and a few pieces of straw placed in it to serve as floats and the saucer kept on the quilt under the cover. Either a hole is cut in the quilt or a corner of the quilt turned over to enable the bees to have access to the syrup.

(3) When a colony has already settled and built combs in a place, the combs are cut out along the line of attachment and fixed into frames which should be fitted with comb fixers. Each comb is fixed on the comb-fixers with its upper edge touching the under surface of the upper bar of the frame. If the upper edge of the comb is not straight a portion can be cut off to make it straight. The bees are smoked plentifully and as they recede the combs are cut one after another, fitted into frames and hung in the hive. Most of the bees will now remain clustering at one place from which they can either be driven into a box as in (2) or scooped up in a bowl and poured over the combs already placed in the hive. They will move down and occupy the combs. Transferring a settled colony in this manner is better done after sunset when the bees do not fly. It can also be done during the middle of the day, but many bees fly and hover round the operator. Also transferring is easily done when the colony is in a box or in a like situation. When in a cavity in tree-trunk or wall or underground a wide opening has to be made to allow of the cutting of the combs with hand. If it be necessary to move the colony to a distance it should be done at night.

Colonies procured according to the methods (1) and (2) sometimes build cross combs and join several frames together. In such cases the combs should be cut and fixed into frames with comb-fixers.

General.

When the bees have settled in the hives it is not necessary to open the hives every day to see what they are doing. On all ordinary days they will work, flying out of the hive and bringing in honey and pollen. For examining the bees, the hive is better opened in the middle of the day when it is warm. First of all remove the roof and blow some smoke under the quilt and wait for a few minutes. Then turn over the quilt and lift one frame at a time slowly by holding the two ends with the thumb and index fingers of the hand.

Although not plentifully as in the honey-flow seasons, the bees usually collect sufficient food throughout the year to keep them going. They need not be supplied with food as long as there is any honey left in their combs. In the rainy season they get little forage outside and if it rains continuously for several days they may require food and may be given sugar syrup in saucers in the manner described above.

When enough surplus honey has been stored in the combs it can be taken out by turning the combs in a proper honey-extractor.

If left opened and exposed, honey absorbs moisture from air and ferments and may become sour. It should be kept in well corked bottles or china or tin vessels and stored in a dry place.

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1921

INSTRUCTIONS ON BEE-KEEPING

BY

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RANGOON

SUPERINTENDENT, GOVERNMENT PRINTING, BURMA

1921

Department of Agriculture, Burma

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Result

OF

Investigations made by the Department of Agriculture, Burma

INTO THE

Extent of the Damage caused by a Parasitic Plant known in Burmese as "Pwinbyu" (*Striga lutea*)

BY

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PWINBYU.

THIS Report is a summary of information obtained in the course of an investigation into the extent of the prevalence, habits and features of the *pwinbyu* parasite in the plains of Burma. The object of the enquiry was to discover some simple, cheap, but effective means for the mitigation of the loss which this parasite frequently occasions the cultivator of *pyaung* (millet). Work began in March 1913 and was carried on up to February 1920; it was then discontinued because it was found to be leading to no workable methods which could be applied against the pest in common practice. As the problems for enquiry were chiefly botanical, the work was conducted by the Assistant Botanist, Mandalay, under the supervision of the Deputy Director of Agriculture, Northern Circle.

In the seven years during which the study of *pwinbyu* engaged the attention of the Botanical Section, the lines of enquiry pursued were the following :—

I.—A study of the plant and its parasitism.

II.—Trials of means to check its spread.

I.—THE PLANT AND ITS PARASITISM.

(i) *The Species, its distribution, and mode of occurrence.*—Of about eighteen species of the genus Striga which inhabit the hotter regions of the Old World as root-parasites upon a variety of hosts, six are distributed in the Indo-Malayan Region. Three of these occur on the plains of Burma,—*Striga lutea Lour*, with a ten-ribbed calyx; and *Striga euphrasioides Benth* and *Striga Masuria Benth*, both with fifteen ribs to the calyx. The plant which formed the subject of investigation was the white-flowered variety of the first-named species,—the *Pwinbyu* (white flower) of the Burmese cultivator. This variety of *Striga lutea* is a slender, gregarious, annual root-parasite, 5 to 20 inches in height, with its aërial parts intensely scabrid and, excepting the purple lower portion of the stem, of a bright or vivid green in colour.

Stem (*a*), *Aërial portion.*—0·05 to 0·1 inch in diameter, cylindrical in the lower part, sub-tetragonous and grooved in the upper; simple or branched; internodes long. (*b*) *Subterranean portion.*—Two to three inches in length; simple or cylindrical throughout, short and somewhat thicker than the aërial (particularly in young individuals), internodes short and sometimes flexuose; terminating abruptly in a blunt or conical tip or prolonged into a root.

Branches opposite (decussate), subopposite or alternate (especially in the upper portion of the stem), suberect of fastigiate.

Leaves 0·5 to 1·5 inches in length and 0·05 to 0·2 inch in breadth; like the branches in phyllotaxy; sessile; linear or lanceolate; subcoriaceous; margins entire; midrib and lateral nerves prominent on the lower surface; the leaves are reduced to ovate or broadly triangular leathery or fleshy scales on the lower and subterranean portions of the stem.

Flowers axillary or in lax terminal spikes; bracts linear, longer than the calyx-tube; bracteoles 2, linear, about one-third the calyx.

Calyx—tubular, 0·2 to 0·3 inch in length; ten-ribbed, cleft at the mouth into 5 linear-lanceolate teeth; scabrid; membranous between the ribs; persistent and cleft to the base in the ripe fruit.

Corolla—white; its tube about twice the calyx, 0·05 to 0·06 inch in diameter, dilated in the lower half, the limb 0·3 to 0·4 inch in diameter, puberulous beneath; rotate, oblique bi-partite, the upper segment broadly obovate-notched and about twice as broad as it is long, the lower divided into three subequal obovate segments of which the two lateral are often oblique.

Stamens—4, didynamous, inserted in the woolly-hairy throat of the corolla-tube; filaments short, erect, stout; anthers one-celled, introrse, dorsifixed.

Pistil—bicarpellary; carpels membranous; ovary superior, ovoid-oblong, obscurely grooved, with a conspicuous gland (nectary?) on one side of the base; ovules indefinite; style filiform; stigma terminal, bifid.

Capsule—(0·125 to 0·3) by (0·1 to 0·125) inch, ovoid-oblong, laterally sub-compressed, grooved on the suture and (more obscurely) down the median line of each carpel; the rounded apex is abruptly terminated by the stiff and persistent base of the style.

Seeds—0·008 by 0·006 inch; 195,000 per gramme or about 5,500,000 per ounce; ovate-oblique; testa hard, chitinous, rugulose, dark brown. They resemble particles of dust and sink in water.

Roots—cylindrical, succulent, fragile, arising singly anywhere on the underground portion of the stem as well as crowded in a mass about its base; they are white or streaked interruptedly with red and terminate in succulent globose, pyriform or irregular haustoria which are from 0·039 to 0·098 inch in diameter, such haustoria also forming at intervals, singly or in groups, on one or more sides of the roots which may or may not thicken or become torulose about them; the apices and sides of the haustoria, when in contact with the roots of the host, flatten or, by their continued growth, almost wholly enclose and include the latter. A spindle-shaped core of tissue (sucker) forms in the body of the haustorium when intimate contact with the root of the host is established. All the roots of the plants examined were found attached by haustoria to the roots of the host and none of them traced as leading a separate existence independently in the soil. Even in the youngest plants connection with the host is established first before their emergence above the ground. The roots and haustoria, when placed in water for more than a day, deliquesce into blue or purple masses; and all parts of the plant become black on drying.

(*N.B.*—The original Drawings made to illustrate this description are appended.)

This variety of *striga lutea* is also known by the local names of *Kwin-bin*, *Gwin-bin*, *Mogyo-laung-mi*, *Thagya-laungmi*, *Pyaung-that-bin*, *Pyaung-sa-bin*, *Naga-thein* and *Naga-thè* and is distributed throughout the Burmese Dry Zone as well as in the districts that adjoin it and grow *pyaung* for food or fodder. In this tract of country the area under *pyaung*—the third most abundant crop of the Province—is about 650,000 acres per annum; and, from the reports furnished by district officers, it is apparent that the crop is subject to the parasite over almost the whole of this vast area,—the pest affecting the *pyaung* in a variety of soils and situations, but being most abundant and aggressive wherever the conditions for the growth of *pyaung* are least favourable or propitious, especially in respect of the capacity of the soil to retain the moisture which it receives. Accordingly, *pwinbyu* flourishes best, *i.e.* attains soonest to maturity and produces the greatest quantity of seed where *pyaung* is grown on the poorer and lighter soils, such as *kyat-ti-mye* and *putchi-mye*, that are typical of the higher "upland" *yas* which dry out quickly after rain and which, through the continuous cultivation of *pyaung* and other crops, have been exhausted to the verge of sterility. On the heavier, deeper and more fertile soils which occur in the depressions and other low-lying situations as well as under the shade of trees or even of *pyaung* crops which get an early start and grow up quickly tall and dense, the pest is sparser, of leaner habit, with longer internodes and fewer capsules that are slower in maturing.

Pyaung is sown from June to September and *pwinbyu* which begins to appear in about a month after the sowing of the *pyaung* is noticeable most from August to November, when its masses of white flowers make it conspicuous amidst the light green stalks of the *pyaung* which is then about three or four feet in height. It occurs in patches or scattered about the fields and is particularly in evidence, in most places, from the middle of September to the end of November, after which it begins to seed and die down, drying up into black brittle masses in the hot weather. Either singly or, more usually, in groups that are often dense, it appears above the ground, flowers, and seeds down throughout the season of growth of the *pyaung*; so that, between August and December, on any one field at any given time, *pwinbyu* plants in all stages of development may be seen growing beside one another. The *pyaung* is cut in January or February,

but clumps of *pwinbyu* in full flower and fruit may often be seen flourishing in the stubble. These late plants, too, die after seeding; so that, by the middle or end of March, there are few signs of the pest anywhere in the tract.

If the soil of a field which is even normally infested be examined in the middle of the growing season, it will be found to be full of *pwinbyu* seedlings in various stages of germination and growth,—all of them attached to the roots of the *pyaung*. These underground plants frequently occur in such immense numbers as to lead to the belief that the majority of them must live and die without emerging into the light; for, if they did, it would be impossible for them to find standing room on the field. The plants, then, that appear above the ground are but some of the myriads that have germinated and but a moiety of the numbers that, at any time, actually live upon the host. A very large quantity of ungerminated seed will also be found lying about in the soil.

Pwibyu is propagated exculsively from seed, of which immense quantities are produced in the season (September to April) and are added to the very large quantity of it preduced in previous seasons which did not, from various causes, germinate; under normal conditions, therefore, a soil on which infestation once begins acquires an increasing amount of the seed with every *pyaung* crop grown upon it. The underground portions of the stem and roots, even when left attached to the host, are incapable of giving rise to shoots or suckers; but should a plant be broken off close to the ground so as to leave even a small portion of the aërial part of the stem alive and attached to the parts underground, copious coppicing results in the formation of a vigorous bush with fastigiate branches which, as an agent of infestation, is infinitely more potent than the simple-stemmed form which it replaces.

Of the agents concerned in the dissemination of the seed, wind is, by far, the most important. The plant, when dry, is extremely light and can therefore be bodily carried by wind. The minute seed, though not scattered to any distance from the plant producing it by the dehiscence of the capsules, is nevertheless, light enough to be raised with the dusty soils it lies in and carried easily far and wide by the whirlwinds and dust-storms that blow over the bare and open country in the hot weather. Among the other more common agents which help in the carrying and scattering of the seed are moving water, grazing cattle, the carting about of infested *pyaung* crops, the sowing of *pyaung* seed between the glumes of which the seed of the pest has found a lodging, manuring with infested cattle dung, carts, implements and the persons of the cultivator.

Besides *pyaung*, the hosts of *pwinbyu* are most of the commoner weeds of *pyaung* fields as well as some of the crop-plants grown in rotation with *pyaung* or in the nighbourhood of *pyaung* fields. From the "List of Hosts," determined by observation, it will be noticed that, if there is a preference, it is apparently shown towards a member of the Graminaceae; but that for the rest, it seems to be evident that there is no discrimination in the selection of hosts; for, among these may be counted species with affinities that are both distinct and remote,—the five species recorded under "B" in the List, being taxologically referred to as many Families.

List of Hosts affected by Pwinbyu (as determined in the Botanical Laboratory, Mandalay.)

A.—GRASSES.

I.—Cultivated Grasses.

1. Pyaung	...	... Sorghum vulgare, *Pers.*
2. Pyaung-bu	...	... Zea Mays, *Linn.*
3. Lu	...	... Panicum miliare, *Lamk.*
4. Sât	...	... Setaria italica, *Beauv.*
5. Kala Sât	...	... Pennisetum typhoideum, *Rich.*
6. Teosinte	...	... Euchlaena mexicana, *Schrad.*
7. Sudan Grass	..	... Holcus sudanensis.

II.—Wild Grasses.

1. Sin-ngo-myêt	...	Panicum flavidum *Retz.*
2. Zein-myêt	...	Panicum prostratum *Lamk.*
3. Myêt-lú	...	Panicum distachyum *Linn.*
4. Myêt-kha	...	Panicum repens *Linn.*
5. Wayôn-myêt	...	Panicum, sp.
6. Wumbè-sa-myêt	...	Panicum colonum *Linn.*
7. Myin-sa-myêt	...	Cynodon dactylon *Pers.*
8. Myêt-lègwa	...	Eleusine aegyptiaca *Forsk.*
9. Padaw-pyu	...	Andropogon annulatus *Forsk.*
10. Padaw-ni	...	Andropogon caricosus *Linn.*
11. Myêt-môn-hmwa		Sporolobus coromandelianus *Kth.*
12. Myêt-kyein	...	Eriochloa polystachya *H.B.K.*
13. Myêt-thamin	...	Aristida adscenscionis *Linn.*

B.—Other Species.

1. Myin-kwa	...	Ipomaea reniformis *Chois.*
2. Môn-nyin-u	...	Cyperus rotundus *Linn.*
3. Myêt-kaukhnyin	...	Desmodium gyroides *DC.*
4. Kyauk-pilaw	...	Corchorus fascicularis *Lamk.*
5. Sú-lè	...	Tribulus terrestris *Linn.*

In the course of the investigation, reports were received from district officers to the effect that *pwinbyu* was parasitic upon Sesamum, Cotton, Beans and "other crops" sown with or after *pyaung*, that "if it appeared all or most crops were destroyed," and other statements of a similar purport. These reports were so conflicting that it was decided to test their accuracy on the field by associating *pwinbyu* with all the crop-plants that are usually cultivated in the tracts affected. The results of the experiments clearly indicated that *pwinbyu* seed was *not* germinated by any of these plants.

List of Hosts not affected by Pwinbyu (as determined in the Botanical Laboratory, Mandalay.)

A.—Beans.

1. Myè-pè	...	Arachis hypogaea *Linn.*
2. Pè-sin-ngôn	...	Gajanus indicus *Spreng.*
3. Pè-gya and Pē-byu-galè	...	Phaseolus lunatus *Linn.*
4. Mât-pè	...	Phaseolus Mungo *Linn.*
5. Pè-di-sein	...	Phaseolus Mungo, var. radiatus *L.*
6. Pè-yin	...	Phaseolus calcaratus *Roxb.*
7. Pè-gyi	...	Dolichos Lablab *Linn.*
8. Pè-bizât	...	Dolichos biflorus *Linn.*
9. Kalá-pè	...	Cicer arietinum *Linn.*
10. Pè-lôn	...	Vigna Catiang *Endl.*
11. Pè-chinbaung	...	Lathyrus sativus *Linn.*
12. Pè-yáza	...	Lens esculenta *Moench.*

B.—Other Species.

1. Hnán	...	Sesamum indicum *DC.*
2. Wá-galè	...	Gossypium neglectum *Tod.*
3. Khayán-chin	...	Lycopersicum esculentum *Miller.*
4. Chinbaung	...	Hibiscus cannabinus *Linn.*
5. Ngayôk	...	Capsicum annum *Linn.*
6. Nān-nān	...	Coriandrum sativum *Linn.*

(*ii*) *Nature and extent of the parasitism of* Pwinbyu.—Experiments conducted in the field and laboratory to throw light upon these features of the parasite gave the results noted below :—

(*a*) **Germination.**

(1) Germination can take place only when the seed lies in contact with the root of the host; otherwise the seed will lie dormant for years. Three successive flourishing crops of *pwinbyu* were obtained from as many annual crops of *pyaung* by artificially infecting the soil of the plots with *pwinbyu* seed in the

[*N.B.*—Pearson says there is evidence to prove that the seed is viable after twelve years of dormancy.]

first year of the experiment ; the result indicating that a good deal of the seed is viable and germinates even after it has lain buried in the soil for three years.

(2) Germination is effected in 10 to 15 days after contact with the root of the host.

(3) Seedlings usually appear above the ground in 39 to 57 days after sowing *pyaung* ; consequently, the seedlings that appear above the ground live under it for about a month after sprouting.

(4) Germination can take place not only on the soil-surface but at all depths up to 12 inches below it, even when the soil is a stiff clay,—the deeper the sowings, the better seeming to be the germination.

(5) No difference was apparent in the readiness with which plants from seed of different ages appeared above the ground from all these depths,—seed three years old seeming to germinate with at least as much facility as new seed, and appearing above the ground at about the same time. Moreover : there was no visible difference between the vigor or density of the crops.

(6) Germination can take place at any time—even the hottest part of the year—if a living host is assured. In an experiment in which *pwinbyu* seed was sown mixed with *pyaung* seed and the *pyaung* kept alive by watering, from time to time, *pwinbyu* seedlings appeared above the ground even in the second week of April, *i.e.* two full months after the season in which the *pyaung* is normally cut.

(7) There is probably progressive maturation of the seed,—a feature which is common to parasites of this class ; and, as has been indicated above, many seeds, by failing to meet the host, escape germination for indefinite periods. Experiments conducted on the Mandalay Farm to determine the number of crops of *pyaung* that are required to germinate all the seed (about one ounce) sown in a plot of land 4 feet by 4 feet gave the results noted below :—

Four plots of land were placed under crop ; in the first, nine succesive crops were sown between the 12th June 1917 and the 6th December 1918 and *pwinbyu* was germinated by the 1st, 2nd, 3rd, 5th, 7th and 8th crops. The 4th, 6th and 9th crops probably caused some germination, too, but the plants did not appear above the ground. In the second plot, six successive crops were sown between the 12th June 1917 and 18th November 1918 and *pwinbyu* was germinated by all the first five. In the third plot, six successive crops were sown between the 12th June 1917 and 6th December 1918 and *pwinbyu* was germinated by all six. In the fourth plot, five successive crops were sown between the 12th June 1917 and 6th December 1918 and *pwinbyu* was germinated by all five. In the season of 1919-20, three more crops were grown on the first plot and *pwinbyu* appeared in the last two, *i.e.* the 11th and 12th crops. There was no apparent sparsity of *pwinbyu* in the later or even the last of these crops.

(*b*) Parasitism.

(1) Parasitism begins with the germination of the seed and is absolute or complete, *i.e.* the parasite lives entirely at the expense of the host, during the whole of the underground stage of its existence. Consequently, the greatest relative amount of injury which it can effect up on the host occurs, probably, before the parasite appears above the surface of the ground. After it appears above the ground, parasitism is partial or incomplete ; the presence of chlorophyll helping in assimilation.

(2) The results of pot-culture experiments conducted by the Agricultural Chemist indicated that the transpiration-stream was appreciably impeded in *pyaung* infested with *pwinbyu*, even at an early stage of its growth. The absorptive capacity of the roots of the *pyaung* was apparently impaired, the infested plants seeming to be unable to take up water from the soil even when water was present in quantity. The Chemist's experiments showed the following :—

(*a*) *Maximum Water*—

	Transpiration (lbs of Water).	Dry matter (lbs.).	Water per one lb. of dry matter (lbs.)
Pyaung alone ...	128·1	12·75	161·7
Pyaung with Pwinbyu...	100·8	8·25	194·9

	Transpiration (lbs. of water).	Dry matter (lbs.).	Water per one lb. of dry matter (lbs.).
(*b*) *Intermediate Water*—			
Pyaung alone ...	116·1	13·25	141·2
Pyaung with Pwinbyu ...	72·7	6·25	185·6
(*c*) *Minimum Water*—			
Pyaung alone ...	78·6	9·75	128·6
Pyaung with Pwinbyu ...	51·1	4·25	194·6

(3) Although the roots of *pwinbyu* which have no root-hairs and are fixed by haustoria to the more succulent roots of the *pyaung*, absorb nutriment from the latter (*cf.* C.A. Barber in "Agricultural Journal of India," Vol. I, page 169) and impair their absorptive powers, unlike Fungi, they do not set up disease within the tissues of the host. Their action results in the diversion, for the purposes of the parasite, of the transpiration—stream of the host and in the consequent starvation and strangulation of the host; the death of the host not, however, appearing to supervene, in most cases, until after the parasite goes to seed.

(*c*) Extent of damage.

As, under normal conditions, the failure of a crop of *pyaung*, even when it is infested with *pwinbyu*, may be attributed to the prevalence and co-operation of a variety of destructive factors, it is impossible to estimate the extent of the damage which the pest itself causes the crop it infests. The results of experiments conducted at Mandalay indicated that the approximate loss to the *pyaung* varied from 4 to 46 per cent. of the crop; but, in estimating the significance of these figures, regard must be had to the circumstance that they were obtained from experiments conducted on clay soils on which infestation is usually less pronounced than it is on the lighter soils of the *pyaung* tracts. On these it may well amount to more; but even then *pwinbyu* may not be the chief determining factor of crop-failure.

II.—Trials of means to check the spread of *Pwinbyu*.

The remedial measures that have been tested may be classified under two distinct heads—(*a*) *Direct methods of killing* which consisted in the application of cheap chemical substances as "dressings" to the soil to kill the *pwinbyu* without killing the *pyaung*; and (*b*) *Indirect killing by "decoy"-cropping* in which it was sought to induce the *pwinbyu* seed lying in the soil to germinate upon a preliminary ("decoy") crop of *pyaung* which was then ploughed up to destroy the *pwinbyu*; the *pyaung* crop of the season being sown after the cleaning of the soil by the removal of the "decoy" crop. The results of the experiments are summarised below:—

(*a*) *Direct Killing*.—Common Salt, Saltpetre, Nitrate of Soda, Nitrolime, Superphosphate, Copper Sulphate, Sulphate of Ammonia and Potassium Nitrate were applied to the soil in quantities varying from 50 to 200 lbs. per acre; but without effect upon the *pwinbyu*. The *pyaung* suffered first and was in most cases killed before the *pwindyu* began to suffer.

(*b*) *"Decoy"-cropping*.—The discovery that germination can take place only in the presence of a host plant suggested the sowing of a "decoy" crop of *pyaung*—apparently the most favoured host—and the destruction of the *pwinbyu* before it produced seed, to be followed by another crop later in the season. A preliminary experiment conducted on clay soil in Ywathitkwin, Mandalay, gave the following results:—

Pyaung Crops obtained in lbs. per acre.

Ordinal No. of crop.	Decoy-crop method.		Ordinary cultivator's method.	
	Plot A.	Plot B.	Plot C.	Plot D.
1st crop	2,565	2,033	1,936	2,614
2nd crop	4,937	5,130	...	...
Total ...	7,502	7,163	1,936	2,614

These promising results with the "decoy-crop" method led to its application on a field scale, in 1917 and 1918 in the Sagaing and Lower Chindwin districts; but the results were disappointing for the following reasons :—

(*a*) So far from the early crop clearing the land of the seed of *pwinbyu*, the later crops were as heavily infested as the "decoy" crop. The second crop was, in all cases, poorer than the part of the first crop which was allowed to stand.

(*b*) On the poorer class of soil where the pest does the greatest amount of destruction, the chances of establishing a second crop are very poor. It is often very difficult to establish even one crop; and, if the first seasonal opportunity is missed, it seldom recurs. On the better classes of soil it is often quite easy to establish a second crop, but the necessity for it does not usually arise there. Almost all the second crops failed, and, where a stand was secured, the outturn was less than that of the controls.

Enquiries made in the localities of the experiments elicited the circumstance that the cultivator was averse from destroying crops, merely for the sake of destroying the pests infesting them, because of the difficulty and expense involved in establishing them. Considering the precarious conditions under which the agriculture of the affected tracts is pursued, the point of view of the local cultivator is a perfectly natural one. Thus, the only promising means evolved as the results of our experiments is inapplicable because it is impracticable in the conditions that are prevalent in the tracts affected by the parasite. But, in concluding this Report, I would note the following facts :—

(1) The sowing of *pyaung* in rows 18 inches apart, followed by occasional intercultivation given with a wheel-hoe resulted in vigorous crops despite dense infestation by *pwinbyu*.

(2) Thorough cultivation, drainage, manuring, early sowing, which tend to produce tall, vigorous and shady *pyaung* crops early in the season minimise the loss from *pwinbyu* infestation.

(3) The burning of stubble and rubbish on the field after harvest destroys the seed of the pest lying on and near the surface of the ground.

(4) Rotation of crops so as to restrict the opportunity of the pest of producing seed more than once in a period of years would tend to the gradual elimination of the seed from the soil, provided that the weeds and grasses which can serve as alternative hosts to the parasite are also destroyed as they appear and reinfestation from outside is guarded against. But no operations against the parasite and its inroads are likely to be successful except in a very local and empirical way, unless those interested in the cultivation of *pyaung* in the whole of the tracts affected take part in co-operative and systematic campaigns against it. Otherwise, their lot will be similar to that of people elsewhere in the world who have long since been resigned to losses caused by weeds similar to *pwinbyu*; losses which are however, undoubtedly, avoidable because weeds are the result of bad cultivation.

A. M. SAWYER,
Senior Assistant Botanist.

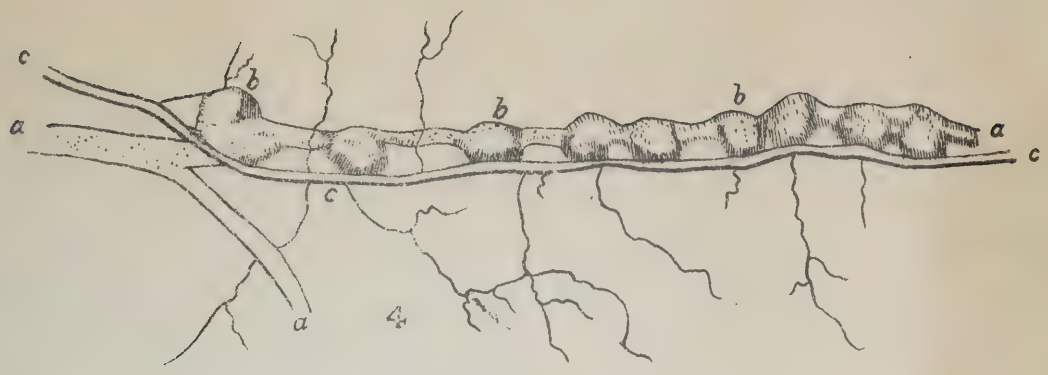
The 24th May 1921.

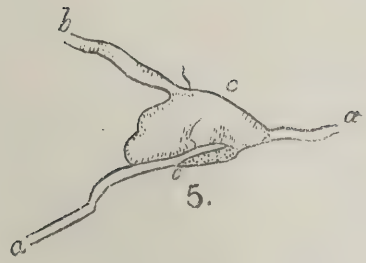
G.B.C.P.O.—No. 21, D. of A., 8-2-1922—600.

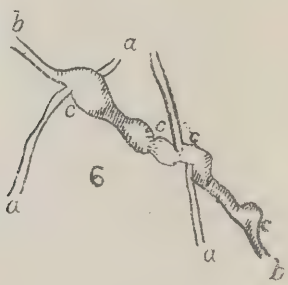
(a) & (b) *Young Pyaung plants attacked by*
(c) *A Pwin-byu plant.*

The Pwin-byu had gone to seed and the Pyaung plants were dying.

a—a A Myin-kwa plant attacked by
b.and c. two matured Pwin-byu plants.







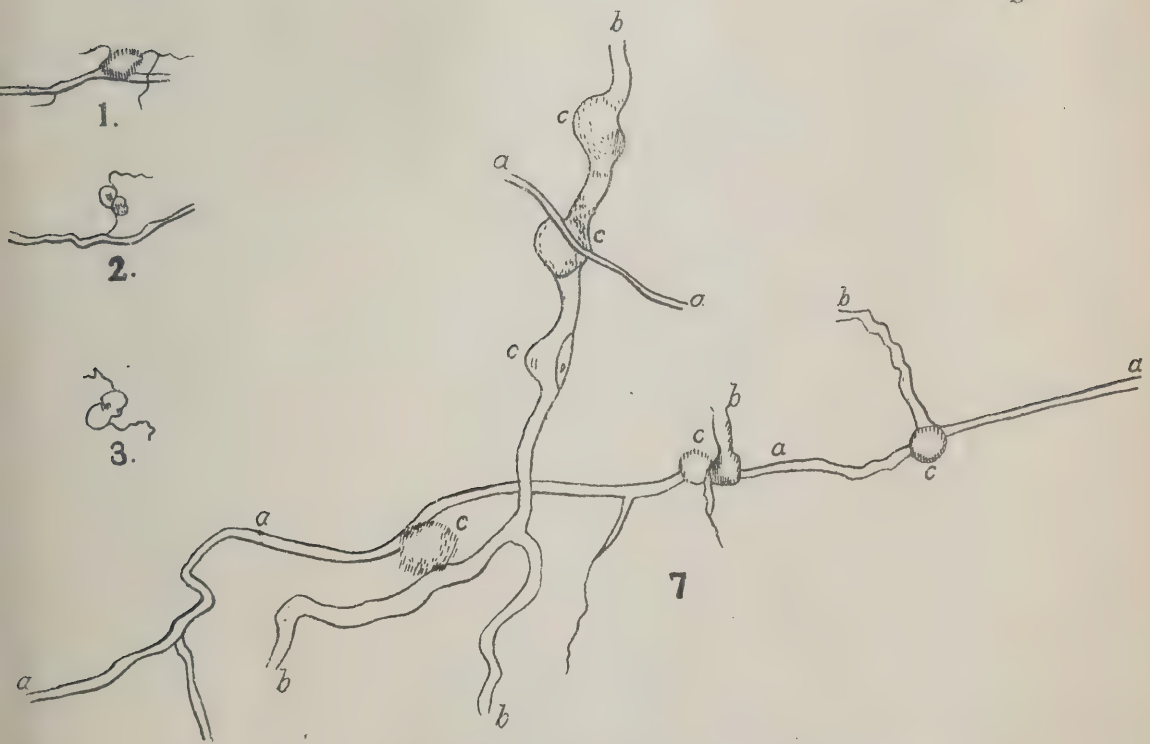


Fig. 1. Haustorium of Pwin-byu on root of Myin-kwa

Fig. 2 and 3. Haustorium of Pwin-byu on root of Panicum.

Fig. 4 a.a.a. *Root of Pwin-byu*
b b b *Haustoria on a.a.a.*
c c.c. *Root of Pyaung attacked* } *(much enlarged)*

Fig. 5, 6 and 7. Roots and haustoria of Pwin-byu attacking roots of Panicum.

a.a.a. *Roots of grass (Panicum)*
b b.b. *Roots of Pwin-byu*
c c c. *Haustoria of Pwin-byu* } *(much enlarged)*

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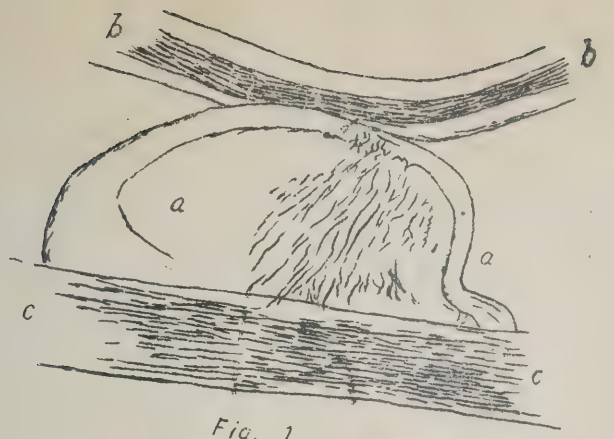


Fig. 1.

Fig. 2.

Fig. 1 *Longitudinal section through a haustorium and root of Pwin-byu and root of Pyaung.*

a.a. *Haustorium (notice core of tissue about the centre)*

b.b. *Pwin-byu root bearing it.*

c.c. *Section of root of Pyaung attacked.*

Fig. 2. *Longitudinal section through haustorium and root of Pwin-byu and root of Pyaung.*

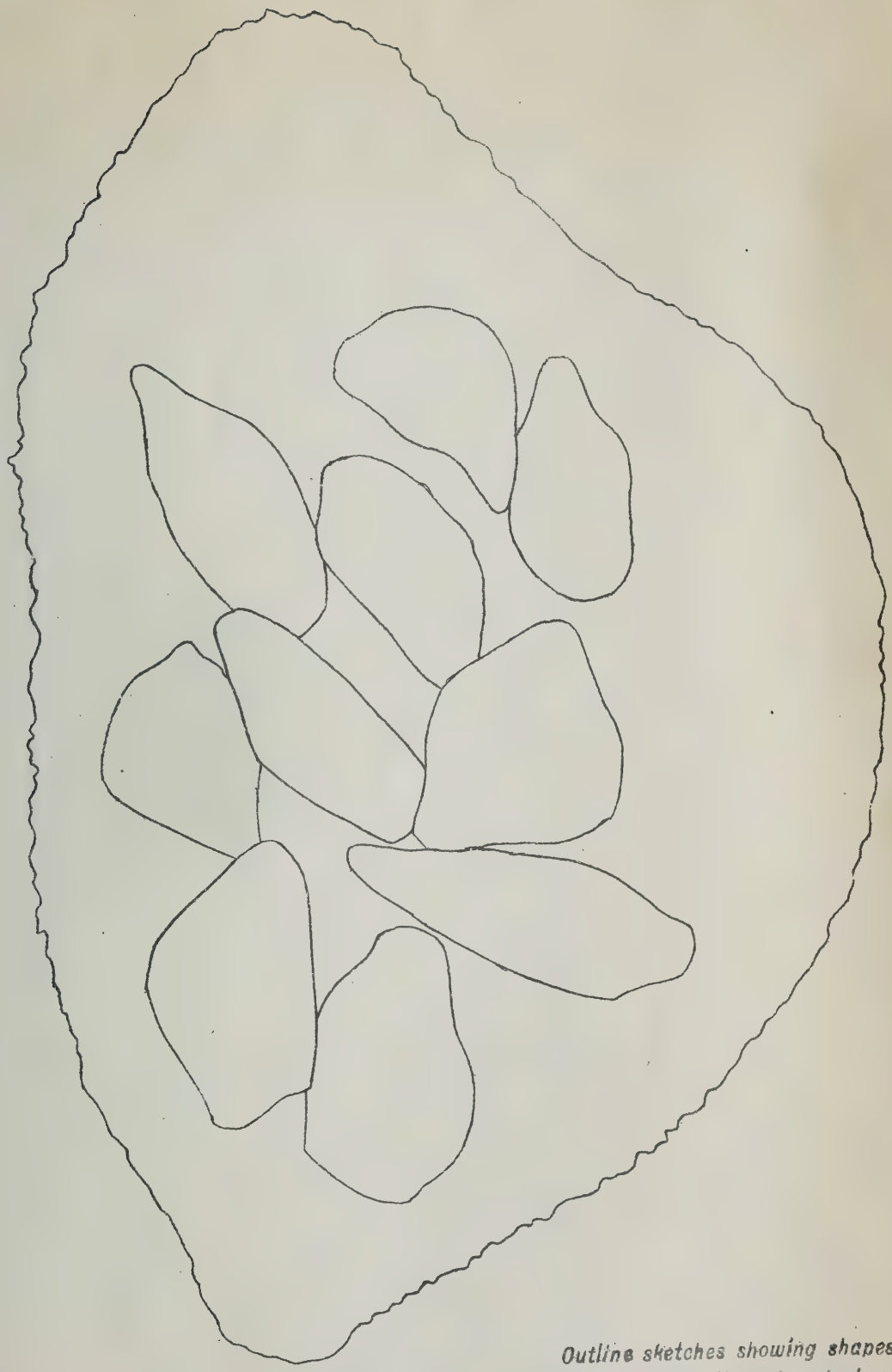
a.a. *Root of Pyaung.*

b.b. *Root of Pwin-byu.*

c.c. *Haustorium.*

d. *Spindle-shaped bundle of tissue, sucker is at base of d.*

DRAWING 5



Outline sketches showing shapes of Pwin-byu seeds; the outer seed very much enlarged, to illustrate the rugulosity of the testa.

G.B.C.P.O.-No.21, D.of A. 9-2-1922. 600. T.L.M.

Department of Agriculture, Burma

BULLETIN No. 18, 1921

Result

OF

Investigations made by the Department of Agriculture, Burma

INTO THE

Extent of the Damage caused by a Parasitic Plant known in Burmese as "Pwinbyu" (*Striga lutea*)

BY

A. M. SAWYER,

SENIOR ASSISTANT BOTANIST, MANDALAY

RANGOON

OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, BURMA

1922

Department of Agriculture, Burma

BULLETIN No. 19

THE PALM BEETLES IN BURMA

WITH NOTES ON OTHER PALM PESTS

BY

C. C. GHOSH, B.A., F.E.S.

ENTOMOLOGIST, MANDALAY

UNIVERSITY OF ILLINOIS

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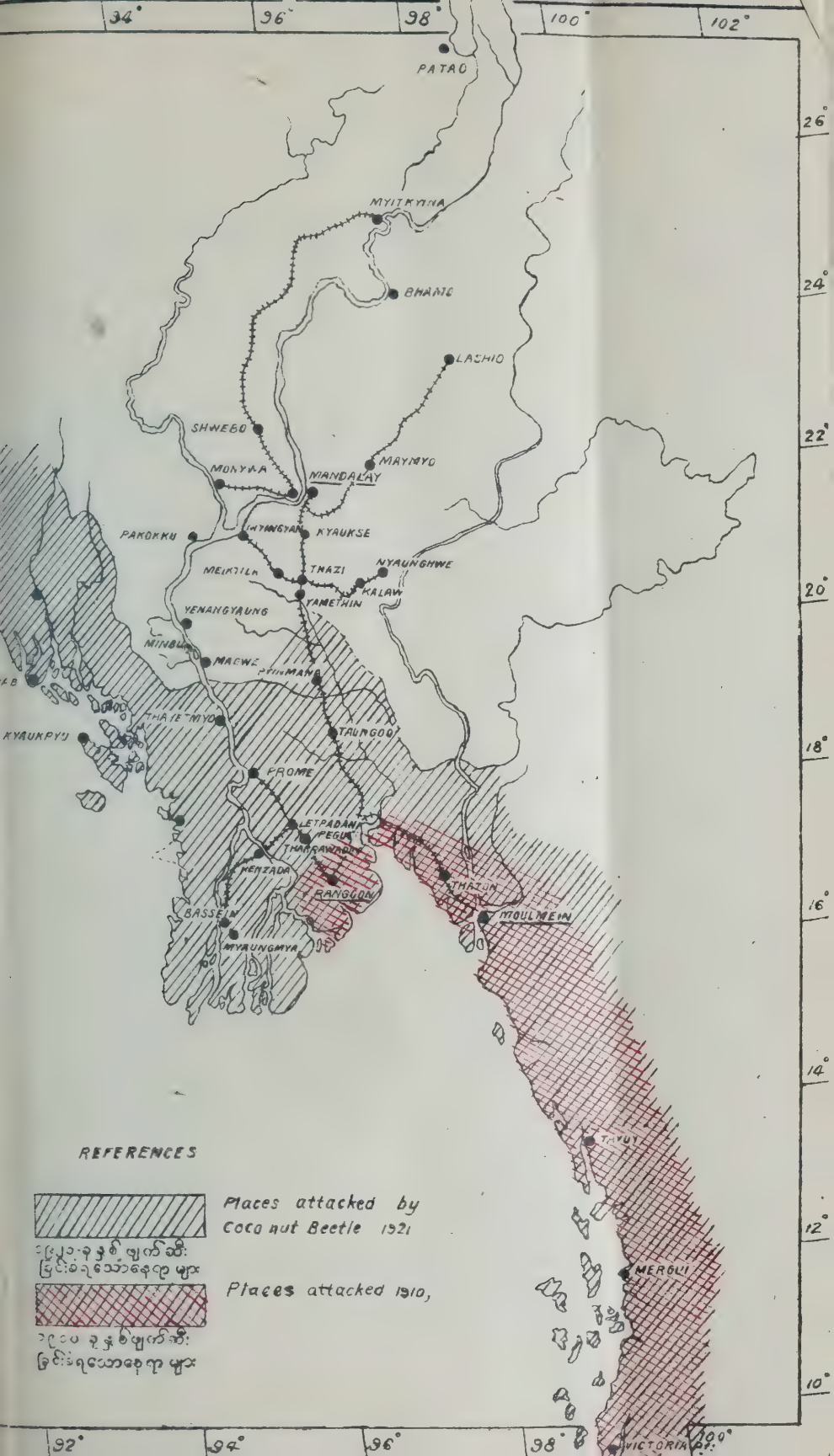
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Places attacked by Coco nut Beetle 1921
Places attacked 1910,

THE PALM BEETLES IN BURMA

WITH NOTES ON OTHER PALM PESTS.

INTRODUCTORY.

THE coconut is grown throughout Burma, although its cultivation on comparatively large scale is mostly confined to some of the sea-coast districts. The cultivation in many villages in the interior is by no means small. The crop obtained however is very much below the demand and coconuts of the value of about eight to ten lahks of rupees are imported annually into the Province. There is ample scope of extending the cultivation and suitable lands are available all along the seacoast. But the cultivation, instead of extending is fast decreasing, chiefly owing to the ravages of insects, of which the rhinoceros beetle or the black coconut beetle is the most important. What the effects of the activities of this beetle have been, can be partly gauged by the following facts. Messrs. MacKenna and Shroff recorded in 1911, that prior to the appearance of this beetle in this province about 1895, the maritime districts of the Tenasserim Division were said to be able to meet the local demand for coconuts, but they were now very heavy importers from the Straits. An old resident of Thayetmyo informed the present writer that green coconuts which could be had there for three-quarters of an anna in 1891 were selling at eight annas in 1921. Nowhere in Burma at present a green coconut can be had for less than two annas, the average price being about four annas. Taking the circumstances as they are at present the coconut trees are a valuable asset to the people. Serious efforts should be made not only to save the existing trees but to bring about conditions which will admit of extension of cultivation. Attempts however at extending the cultivation or introducing new varieties of palms including the African Oil Palm, will be seriously hampered unless the pest can be checked. Its ravages have continued unchecked and the insect itself has been rapidly spreading into new districts, as will appear from the map (Plate I) indicating badly affected areas in 1910 and 1921. Unless vigorous measures are adopted to cope with it the coconut runs the

risk of disappearing altogether from the province. One has only to visit places like Pyinmana, Thayetmyo and Hanthawaddy to be convinced of the truth of this statement. The evil will not stop with the disappearance of the coconut. The beetles will then turn their attention exclusively to palmyra, *dhani* and other palms, which at present escape serious damage owing to the presence of the more favoured coconut.

Apart from the damage they themselves are capable of doing to the plants the beetles are known to carry and distribute germs of very bad forms of diseases like the bud rot, among the trees and thus have immense potentialities of further mischief not only to the coconut but also to the palmyra palms, in case an epidemic disease occurs. This is an additional reason why vigorous control measures should at once be adopted.

Unfortunately the owners themselves of the trees, through their ignorance of the life-history and habits of the pest provide it with ample breeding facilities. If they pay attention to the breeding places near their own dwelling-places, *viz.*, the heaps of rotting farmyard manure and of rotting straw and dead palm stems, the question of controlling the pest is at once solved. A poster has been prepared for distribution in the whole province in order to draw the attention of the people to this fact.

The coconut in Burma suffers from the attack of four major pests which are the following :—

(1) The rhinoceros beetle or the black coconut beetle (*Oryctes rhinoceros*, Linn.)

(2) The elephant beetle (*Xylotrupes gideon*, L.).

(3) The red weevil or the plam weevil (*Rhynchophorus ferrugineus*, Oliv.).

(4) The palm leaf nibbling caterpillar (*Nephantis serinopa*, Meyr.).

Out of these the rhinoceros beetle is the worst and is principally responsible for the death of the trees as it bores and kills the growing top of the stem. It has been under observation in Burma for a long time. A cultivator's leaflet (No. 17) was issued in 1909 and a bulletin (No. 4) by Messrs. MacKenna and Shroff in 1911. The present writer joined the Burma Agricultural Department in 1920, and took up the study in March 1921. The present bulletin gives the results of his observations both in the fields and in the laboratory extending over a period of about one and a half years.

The presence of the elephant beetle as a pest of the coconut was not suspected by previous observers. In fact

this beetle has not hitherto been recorded from this province. On investigation however it has been found to be widely prevalent, damaging the trees even in places where the rhinoceros beetle is not present. It has so far been noted to confine its ravages to leaves and leaf stalks. The ragged appearence of the trees in the form of trimming and punching of the leaves, gnawing of the leaves and leaf-stalks and breaking of the leaf stalks, is principally due to the activities of this beetle.

The red weevil where present usually follows the rhinoceros beetle and also probably the elephant beetle and frequently aggravates and completes the damage started by the latter. The three can hardly be separated. An account of the observations so far made in Burma on the weevil is therefore added.

The remedial and preventive measures which are advised to be adopted against the rhinoceros beetle will include the red weevil as well as the elephant beetle and if carefully carried out will be effective against all the three insects at the same time.

It has been considered useful to add a short account of the leaf-nibbling caterpillars which confine their ravages only to leaves.

THE RHINOCEROS BEETLE (*Plate III*).

(*Oryctes rhinoceros*, Linn.)

How the Rhinoceros Beetle feeds and damages the Coconut.

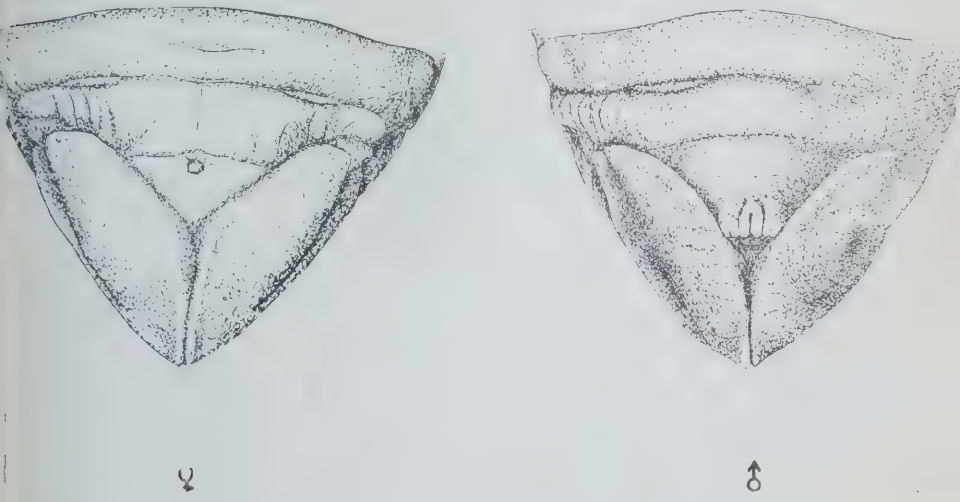
The rhinoceros beetle (Plate III, figs. 2 and 5) is well known to the owners of coconut trees in the localities where it occurs. It flies at night and bores the tops of palm trees by gnawing a large hole at the base of the heart leaf or of one of the outer leaves It bores down into the stem and may go down as much as about a foot or even more. When the growing point or heart is damaged the tree ceases to grow and bear, gradually dwindles away and ultimately dies. Repeated attacks hasten the end. Frequently the beetle gnaws across the unfolded and unopened central leaves and such leaves on opening look to have been trimmed or punched (Plate II). The beetle primarily bores these holes simply to feed by cutting away and chewing the fibres and extracting the juice from them. The chewed-up loose fibres sticking out of the holes proclaim its work. Serious consequences however follow. The holes being large, up to about 1½ inches in diameter, the beetles find a shelter in them during the daytime. Several beetles are frequently found in the same hole which is gradually enlarged by the temporary occupants. All beetles are active and fly at night and therefore the same beetle does not probably continue to live at one place. Rain water lodges in these holes and sets up decay. When the pith rots it forms an ideal breeding place where eggs are laid and the resultant grubs feed. The end may be hastened by the red weevil or fungal and bacterial diseases. Gradually the crown falls off and the stem stands like a tall mast. The trees in infested areas present a poor appearance with scanty leaves and are in marked contrast to healthy trees with abundant spreading leaves and bushy crowns. These facts are matters of common observation and well known to the people.

Food Plants.

Besides the coconut, the rhinoceros beetle is known to feed on various other kinds of plants of which the following are known to occur in Burma.

FIG. 1.

A young Palmyra Palm with punched leaf. The rhinoceros beetle does not eat leaves, but, while boring at the top of the stem, may gnaw through an unopened leaf which on opening looks punched.



♀ ♂

FIG. 2.

Ventral surfacesof the hinder parts of male and female pupa.

The palmyra palm or the toddy palm (*Borassus flabelliformis*).—This is of great economic importance and is grown extensively in many districts, such as Magwe, Minbu, Pakôkku, Myingyan, etc., for toddy and jaggery. Its leaves are used for thatches and for making mats and *da-gauk-pha*, a kind of box in extensive use in Burma. The stem yields a very strong timber and the fruits are eaten both in young and ripe state.

The *dhani* palm (*Nipa fruticans*).—This also is of economic importance, its leaves being used for thatching purposes. A drink is obtained from it. It is of a more wild nature than the above and grows in the form of thick bushes in damp places, especially along the banks of the numerous creeks in Lower Burma.

The common wild date palm (*Phoenix sylvestris*).—This also is of economic importance. A toddy and jaggery are obtained from the trees. The fruits are eaten and leaves used for mats and other purposes.

The talipot palm, Burmese *Pe-bin* (*Corypha umbraculifera*). —It does not occur wild but is grown here and there in villages, apparently not for any particular purpose but as an ornamental plant.

Pinanga palms, of which three species occur, *viz. P. gracilis*, Burmese *Taw-kun*, in wild state from Chittagong to Tenasserim, *P. hexasticha* in the Pegu Yoma (Hill Range) and *P. hymenospatha* in Moulmein.

The Royal Palm (*Oreodoxa regia*) grown in the Horticultural Gardens, Rangoon.

The following palms which are not known to occur in Burma are recorded to be attacked by this beetle :—

Elaeis guineensis, the African Oil Palm ; *Cocos plumosa* ; *Corypha gebanga* ; *Cyphokentia ? Samoensis* ; *Dictyosperma album* ; *Latania* sp ; *Livistonia chinensis* ; *Hyophorbe amaricaulus* ; *Martinezia carryotae folia* ; *Metroxylon sagus* ; *Phoenix dactylifera*, the Date Palm ; *Roystonia* sp. ; *Sabal* ; *Verschaffeltia splendida.*

The betel nut palm (*Areca catechu*) is not attacked.

Besides palms, the beetle bores agave plants (*Agave sisalana*) and sometimes gnaws sugarcane stem.

The coconut however is liked by the beetle most and is preferred to the others. At present the damage done by it to other plants in Burma is hardly serious and in the case of the *Dhani* and wild date palms practically insiginificant.

The Life History of the Beetle.

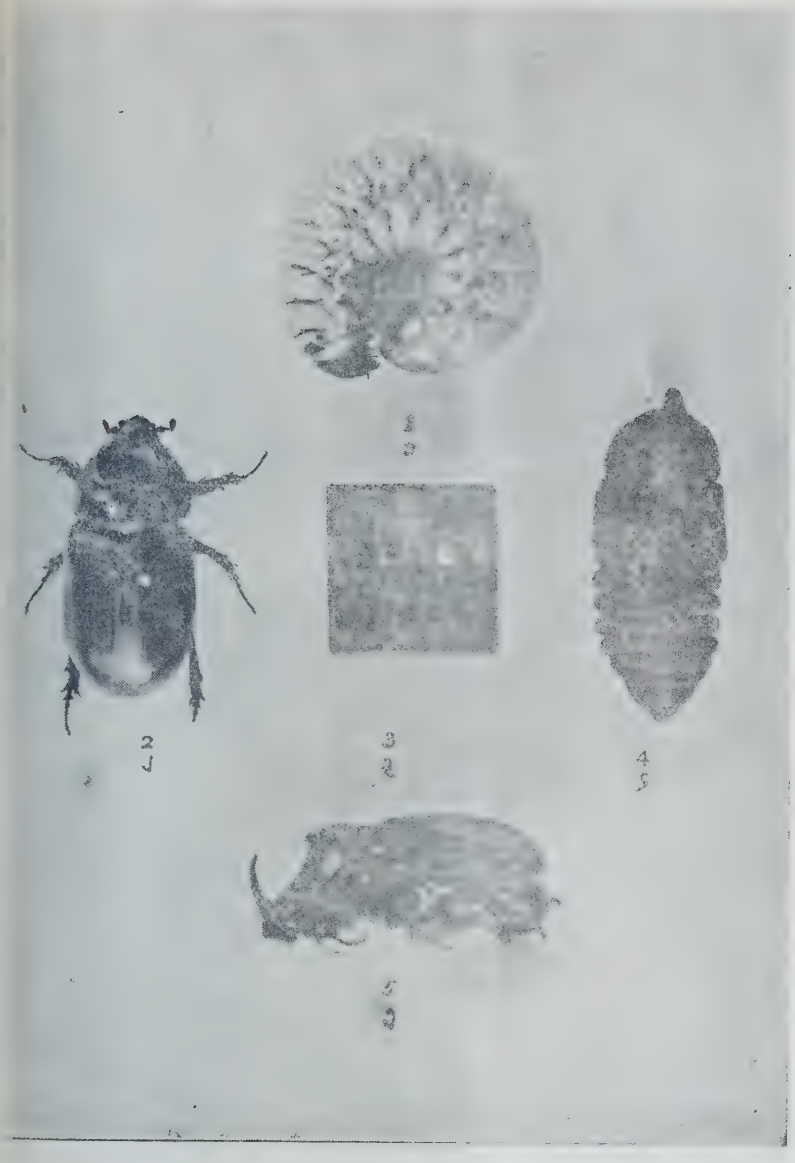
Although feeding on living trees in the adult state the beetle breeds, that is, passes the earlier stages of its life in decomposing vegetable matter or animal excreta. The known breeding places are the following:—

(1) Dead trunks, whether erect or fallen of practically all kinds of palms and agave plants. When the soft parts inside the trunks decompose they form very good food for the young.
(2) Rotting palm and agave stumps.
(3) Coconut, coffee, cocoa and rice husks, leaves and fruit peels, etc., lying in heaps and decomposing.
(4) Decayed dung of cows, horses, goats, sheep, etc. lying in heaps.
(5) Decomposing rubbish of sugarcane mills.
(6) Decomposing heaps of paddy straw and grasses of all kinds, whether in the thatch or lying on the ground.
(7) Rubbish heaps of all descriptions containing decomposing vegetable matter or animal excreta.

The adult beetle lays small round white eggs (Plate III, fig. 3) in these breeding places. From each egg a young one or as it is called, grub (Plate III, fig. 1 shows a grown up grub) hatches out and feeds on the decomposing food and grows. When grown the grub is a large white fat creature commonly known as *po-di-gaung* or *nwa-chi-po-lauk*. When full grown and full fed it moves down generally into the earth or into the denser layers of the heaps, if the heaps be large and transforms into the brown coloured pupa (Plate III, fig. 4) in an oval chamber which it prepares by agglutinating particles of earth or other material in which it has been living (Plate IV). When pupating in straw heap sometimes cocoons of twisted straw are prepared. The beetle (Plate III, figs. 2 and 5) emerges from the pupa but does not issue out of the pupal chamber at once. It rests there for a varying number of days before coming out, flying, infesting trees and depositing eggs. The development of the beetle in this manner from the egg through the various stages is described as a life-cycle. The cycle is repeated as in the case of all living creatures. As each female lays many eggs the number of beetles multiplies with every new cycle or brood.

The Life History as observed in other Countries.

The details of life history, have been put on record by various observers. The writer's own observations in the neigh-



The Rhinoceros Beetle grubs (fig. 1) commonly seen in dung heaps, etc., hatch from eggs (fig. 3) laid by the beetle (fig. 2) and pass through the sleeping pupa stage (fig. 4) in order to turn into beetles (figs. 2 and 5). Fig. 5 is the side view of a male beetle showing the horn on the head. The egg when laid is oval and increases in size, becoming almost round before hatching.

Cocoons formed by the Rhinoceros Beetle grubs inside which they pass the pupa stage. The two on the left side are of agglutinated earth and the two on the right side are of twisted paddy straw.

bourhood of Pusa (Northern India) prior to 1911 were published in the Memoirs of the Imperial Department of Agriculture, Volume II, No. 10. There the beetles emerge in May-June and in smaller numbers up to about August and may live up to about November. Eggs are principally laid in May, June and July. The egg-stage lasts about 10 to 12 days, the larval stage about 10 to 11 months and pupal stage about 12 to 13 days. In Northern India therefore the beetle passes through one generation in the year.

In the Federated Malay States, Burkill thinks that the insect passes through two broods in a year. Copeland is of the same opinion as regards conditions in the Philippines. According to Froggatt, Government Entomologist, Australia, eggs are laid in June and July and the resultant grubs pupate and attain the adult stage in October but the beetles do not become active and remain in soil till the following May, there being thus only one brood in a year.

According to Meckie, in the Philippines, the egg stage takes 10 to 12 days, the larval stage 130 to 135 days, *i.e.*, about 4½ months, the pupal stage 30 to 37 days and the adult beetles begin their depredations soon after emergence. The insect thus completes its life cycle in about 5½ to 7 months and may have two generations in one year.

Leefmans records that in the Dutch East Indies, the egg-stage takes 11 to 13 days, the larval stage 63 to 126 days, *i.e.*, about 2 to 4 months and the pupal stage 19 to 27 days. The inactive stage of the beetle lasts for about 14 to 28 days and the adults live for about 4 to 4½ months. According to him, the minimum and maximum periods for a complete life-cycle of the beetle are about 4½ months and 8½ months respectively. Thus there may be one, two or even three broods in a year.

The Breeding Places in Burma.

The principal and probably the only important breeding places in Burma are, farmyard manure heaps, rotting paddy straw heaps and dead palm (principally coconut) stems. The other two possible breeding places are the heaps of paddy husks near rice-mills and those of saw-dust near saw mills. But no breeding has been observed to take place in the mills the writer had the chance of examining. The paddy husks are either burnt, or thrown into water or in some places used as manure in paddy-fields. The sawdust is also periodically

cleared off. Both these substances take long to rot and as they are cleared before they have time to do so, they do not under the present conditions serve as breeding grounds.

Of the three breeding places mentioned, farmyard manure heaps are the most important. All over the villages these heaps are found, consisting chiefly of cattledung and paddy straw thrown out from cattlesheds and also of ashes, vegetable refuse and all sorts of rubbish commonly thrown on them. Generally these heaps are contiguous to the cattle sheds. As they are seldom used as manure they lie in an undisturbed condition for long periods, in most cases until they get converted into earth. They may be added to at the top or edges. Practically all such heaps have been observed to be full of the young stages of the rhinoceros beetle throughout the year. The following figures of collections made by turning over these heaps with spades will give some idea as to how common the insect is in these heaps. Between 23rd and 25th March 1921, two men in a random search of a total period of about six hours in the villages of Yinnyein and Theinzeik in Thatôn District collected 900 specimens, consisting of 27 beetles, 12 pupae, 836 grubs and 25 eggs. In all 30 heaps were examined either partly or wholly. Nine heaps which were thoroughly searched yielded 9 beetles, 12 pupae, 614 grubs and 25 eggs or a total of 730 and average of 81 per heap. The maximum number from an individual heap was 177 and the minimum number 1 (beetle). Two more visits were paid to Yinnyein Village and casual searches made on 3rd August and 26th December 1921. On the former date one man collected in about an hour 188 specimens, mostly grubs, by partly turning over 16 heaps including three small straw heaps. On the latter date by a similar search one man collected 371 specimens in about two hours from 15 heaps. Similar conditions have been observed to prevail in other infested places visited, *viz.*, Pyinmana, Nyaunglebin (by Mr. Clague), Hmawbi, Thayetmyo, Akyab and Sandoway.

The paddy straw heaps form extensive breeding places in the rainy season. No breeding takes place in straw as long as it is dry. The method practised in stacking or heaping straw renders it more suitable for breeding than it otherwise would be. The method of threshing paddy is to get the grains trodden out under the feet of cattle. The straw is thus broken and it is stacked in a loose condition by being heaped on the ground. On the top of the heap the rain water does not get sufficient flow and therefore soaks down to a depth of about half to one foot or even more, causing the entire top to rot.

The base of the heap also soaks water and rots. Rotting paddy straw is the most attractive breeding place and very much liked. Even very small heaps of this substance allowed to lie on the roadside are taken advantage of for this purpose. On the 3rd August 1921 at Yinnyein 34 almost fullgrown grubs were found under a small quantity of paddy straw which would not form a load for a child of five and which was lying on the ground at the base of a mango tree. On the same date 32 young grubs were found under a handful of straw at another place. Under the straw left lying on the ground after the removal of a heap 33 grubs of varying sizes from fullgrown to young and one egg were obtained.

In order to show the conditions in the dead stems of the coconut palms a few typical observations are mentioned here. Similar conditions prevail in all places where the stems of dead and dying trees are allowed to stand or lie about.

Shanzu Village near Pyinmana, 28th December 1921.—The lower part about 9 feet of a dead coconut tree is standing. The upper part about five feet in length has broken off and fallen on the ground, apparently recently. The fallen portion is split open and 64 grubs, old as well as young, are collected from it. In the top of the standing portion one live female beetle, two eggs and 12 grubs are found.

On the same date in a neighbouring village —The standing base about 10 feet left of a dead coconut tree is observed to have been corroded all round just under the bark right down to the roots, the tough vascular central part being more or less intact. The corroded part is converted into dust (the season being dry), and is full of pellets of excreta of the grubs, of which only a full grown specimen is present, the others apparently having gone out as adults.

Shanzu Village near Pyinmana, 4th June 1922.—One coconut tree has broken off at about two-thirds the height according to the statement of the owner. About 13 feet of the stem is still standing. The top is a rotting mass in which the following are found, *viz.*, 9 beetles (6 males and 3 females) 1 pupa and 29 grubs of the rhinoceros beetle.

One tree about 18 feet high has its central leaves dry but eight peripheral leaves are still green. The dry leaves are easiiy pulled off by a man who is made to climb. The bases of the leafstalks are observed to contain empty cocoons of the red weevil. The top of the stem is a rotting mass in which grubs of the rhinoceros beetle are found. The tree is therefore cut down and its top split open and searched. The following are found in it, *viz.*, 3 rhinoceros beetles (2 females

and 1 male), one egg and 26 almost fullgrown grubs of the rhinoceros beetle ; 2 palm weevils (1 male and 1 female), 2 grubs and 59 empty cocoons of the palm weevil. The cocoons are present mostly in the bases of the leaf stalks and a few just under the bark of the stem. Of the weevil grubs one is boring in the fresh part of the stem below the rotting mass and the other is inside a cocoon at the base of a leaf stalk.

Observations in Connection with the Breeding Places.

Paddy straw in wet and rotting condition is the most favourite food of the grubs of the rhinoceros beetle. In fresh cowdung heaps it is the straw which attracts the beetles for oviposition. If cowdung alone is heaped up no insect can bear the heat that is generated in the interior for some time.

Pure cowdung and droppings of horses, goats, etc., do not serve as food for the grub until they are at least several months old and partly decomposed. Heaps of these substances however form very good breeding places when they are old and decomposed, whether there be any straw etc., present or not. The grubs have been observed to feed and live happily in pure cowdung and pure goats' droppings which were converted into humus almost completely.

The grubs cannot live in very wet conditions. No breeding has been observed to take place in farmyard manure heaps which happen to lie in pits with excess of water in the rainy season. If the cowdung, etc., be in a liquid condition breeding becomes impossible. For this reason breeding has been observed to be going on on a larger scale in these heaps in the cold and hot weather than in the rains in Thatôn and other places with heavy rainfall. In Pyapôn District which is in the heart of the affected area the people say that the rhinoceros beetle occurs only in the cold and hot seasons.

Farmyard manure heaps, as already stated are the most important of all the breeding places. Observations go to prove that it is these heaps which enable the beetle to get a footing in new places. The pest has been spreading from the Lower to Upper Burma, *i.e.*, from the south to the north. Even casual observers will notice that the coconut trees in several stations south of Pyinmana are hardly affected to the extent they are in the neighbourhood of Pyinmana. The reason is that plenty of cattle are kept near Pyinmana on account of

extensive cultivation carried on here. The beetle found ample breeding places in the cowdung heaps, multiplied enormously and now it has converted the coconut trees themselves into breeding grounds.

There are many coconut trees on both sides of the Pyapôn River all the way from Twantè to Pyapôn. The rhinoceros beetle is present here. But the coconut trees are hardly affected to the extent they are in Thatôn or Hanthawaddy except in places like Kyaiklat and Pyapôn where the Indians keep cows. In the villages the local people depend mainly on buffaloes for cultivation and keep very few cows or bullocks. No one keeps cowdung. The writer had occasion to visit Pyapôn in the rainy season only when the buffalo dung was observed to lie like a liquid mud. Abundant green grass being available it is hardly necessary to stack paddy straw to any extent in this district.

The Life History as observed in Burma.

The life-history and habits of the rhinoceros beetle were observed in the laboratory at Mandalay and in Yinnyein village in Thaton District. For this purpose this village was visited in March, August and December 1921. Materials for closer observation in the laboratory in the form of grubs, pupae, beetles and eggs, were collected from this village and also from Pyinmana, Hmawbi and other places and kept under rearing at Mandalay. Thatôn has practically an equable climate throughout the year, being never very cold nor very hot. All the places in Burma which are badly infested by this beetle have more or less similar climate. At Mandalay however the hot and cold seasons are more pronounced, it being very hot in March—April, although the cold cannot be described as intense in winter, which again is not of very long duration.

At Yinnyein a few farmyard manure heaps were thoroughly searched on 23rd March 1921 and all grubs, etc., found therein picked up. In two of these heaps live pupae and fullgrown grubs were again present on 3rd August 1921 which attained the adult state in the laboratory in the first week of September. Supposing that eggs were laid in them soon after the first search in March the complete life-cycle is observed to take about five months.

No insect was found in heaps of dry straw in this village in March 1921. But on 3rd August 1921 grubs in all stages

of growth and eggs were common under wet and rotting straw. Oviposition in these situations certainly began after several showers of rain had fallen. The largest grubs found under the straw at the base of the mango tree mentioned above attained the adult state in the laboratory in the first week of September. Supposing that the eggs were laid in May, the period of the life-cycle is observed to be about four months.

In the laboratory at Mandalay the grubs which hatched from eggs laid about the first week of November 1921, pupated early in April 1922 and attained the adult state in the middle of the same month. The life-cycle is thus observed to take about five and a half months.

It would therefore appear that fresh broods occur normally about every four or five months. Some of the insects, however, are slow in development and in their case the period of the life-cycle is very much lengthened. Some of the grubs collected in March did not pupate before the middle of November and again some others collected in December did not pupate before June. The period of the life-cycle in these cases would be about eight to ten months. The number of grubs which developed slowly in this manner however was very few. Although the insect takes such a long time to develop into the adult state it should not be supposed that fresh broods occur only after such long periods. Eggs, grubs, pupae and adult beetles could be collected from the infested villages whenever they were visited, that is in March, June, August and December. Eggs were deposited in the laboratory at Mandalay in March, April, June, July, October, November and December. The grubs kept under rearing pupated and attained the adult state in the laboratory practically in all the months of the year. Breeding is therefore continuous and is going on throughout the year, the broods overlapping one another.

Proportion of Males and Females.

Males and females occur in about equal numbers. Between March 1921 and September 1922 altogether 199 adult beetles were collected and reared in the laboratory and of these 103 were females and 96 males. Out of 49 collected from the villages 28 were females and 21 males. Out of 150 reared in the laboratory exactly half were females and half males. Some more details are given in the statement below showing the season when they were collected or reared.

Number of females.	Number of males.	Collected or reared.	Season.
18	11	Collected, except 1 male reared.	Early hot weather, March 1921.
15	23	Reared ...	Hot weather, June 1921.
27	31	Reared ...	Rains, August-September, 1921.
13	7	Reared 11 females and 6 males; collected 2 females and 1 male.	Cold weather, November 1921 to January 1922.
16	13	Reared ...	Early hot weather, March, April 1922.
9	10	Reared, except 1 female collected.	Hot weather, May-June 1922.
5	1	Reared ...	Rains, August-September 1922.

Distinctions between Males and Females.

Adult male and female beetles can be easily distinguished by looking at the hind end of the body. In males this part is more rounded, smooth, hairless, and glossy and in females it is slightly tapering and clothed with brown hairs. The length of the horn on the head is not a sure guide. The horn frequently is not very well developed in both males and females and some females may have horns much longer than those of some males.

The sex of the pupa can be made out easily by the markings on the ventral surface of the hind end as illustrated in figure 2 Pt. II. The female pupa has a round circular marking on the surface in the centre on the last segment. In the male this marking is non-existent and the hind end of this segment enclosed between the lateral ridges is not pointed as in the female and is further marked by longitudinal indentations.

The sex could not be distinguished in the grub or egg stage.

The Egg.

The egg of the rhinoceros beetle is white with a tough membranous smooth shell. When newly laid it is oval in shape and measures about one-seventh inch in one direction and about one-twelfth inch in the other. With age it increases in size and becomes almost wholly round measuring about one-sixth inch in diameter before hatching.

Eggs have been collected from the breeding places in the infested villages. They have also been obtained from the beetles kept in the laboratory. For this purpose the females and males were kept in glass jars with wire-gauze covers. Moist earth, rotten cattle-dung and rotten paddy straw were provided in these jars and for food of the beetles fresh pieces of coconut leafstalks were supplied. The beetles bored into these leafstalks through the cut ends and frequently converted them into hollow tubes. The jars were emptied out and examined at frequent intervals and food, etc., changed when necessary. Care was taken to keep the females always provided with males. Many females were kept isolated in this manner. In the subjoined statement the record is given of only those from which eggs were obtained.

The female.	Date of attaining the adult state.	Eggs laid.	Date of death of the female.	Total No. of eggs laid.	First eggs laid how long after attaining the adult state.	Length of adult life.
Two females kept together.	1st week of June 1921	3 between 9th—12th July 1921.	1st week of August 1921.	3	1½ months	2 months
One female	1st week of September 1921.	11 on 22nd December 1921.	20th March 1922.	11	3½ „	6½ „
Do.	Do.	4 on 26th Oct. 1921. 3 on 1st Nov. 1921.	11th Nov. 1921.	7	1½ „	2 „
Do.	Do.	4 on 22nd Nov. 1921.	3rd Dec. 1921.	4	2½ „	3 „
Do.	Do.	14 on 22nd Nov. 1921, 6 on 4th Dec. 1921.	7th Dec. 1921.	20	2½ „	3 „
Do.	Do.	9 on 8th Nov. 1921.	22nd Dec. 1921.	9	2 „	3½ „

The female.	Date of attaining the adult state.	Eggs laid.	Date of death of the female.	Total No. of eggs laid.	First eggs laid how long after attaining the adult state.	Length of adult life.
One female.	1st week of September 1921.	5 on 14th Oct. 1921.	26th Oct. 1921.	5	1½ months	1½ months.
Do.	3rd January 1922.	3 on 1st Mar. 1922.	7th Mar. 1922.	3	2 „	2 „
Do.	1st week of October 1922.	4 on 30th Oct. 1922.	6th Nov. 1922.	4	3 weeks	1 „
Do.	Collected 3rd June 1922.	2 on 20th June 1922, 13 on 26th June 1922.	5th July 1922.	15	...	...
Do.	Do.	2 on 20th June 1922, 2 on 26th June 1922.	10th July 1922.	4	...	...
Four females together.	Collected 23rd—25th March 1921.	33 between 8th—11th April 1921.	11th April to 5th May 1921.	33	...	...

None of the females reared in the laboratory commenced laying eggs before about three weeks of attaining the adult state. This is probably not the case in nature. The beetles reared in the laboratory left their pupal chambers 3 to 11 days after attainment of the adult state and in nature egg-laying probably takes place as soon as active life is commenced. At Pusa eggs were laid as quickly as on the fourth day. Leefmans records 20 days as the minimum period.

The number of eggs obtained from individual females under laboratory conditions does not probably indicate the number which a female is capable of laying in nature. The maximum number obtained at Mandalay as shown in the above statement was 20 (the 33 eggs obtained from the batch of four females might have been deposited by a single female). Leefmans has recorded 71 in the Dutch East Indies. In searching the farmyard manure heaps very commonly a number of grubs were found together within a short space and they were of such a uniform size that it would not be wrong to take them to belong to the same batch of eggs laid at the same time. Frequently almost entire heaps were turned over without meeting any grub but a number would be found together at one corner or within a small space at the top. In

one heap at Yinnyein the writer found 25 eggs and 60 newly hatched grubs at one place in March and he believes that these 85 eggs were deposited by a single female. The numbers of older grubs found together in similar situations in different heaps were 109, 83, 76, 40 and 30. It seems that eggs are laid in batches and each female probably lays several batches and therefore several hundred eggs during her long life which under laboratory conditions has been observed to extend up to a period of about 6½ months.

The eggs hatched in 10 to 17 days after being laid.

The Larva or Grub.

The young grub is about a quarter inch long with a brown head and three pairs of well-developed legs. In appearance it resembles the grown-up grub (well-known as *nwa-chi-po*) which when fully developed measures about four inches in length and about one inch across the body. The head is brown and the body white, the hind end being darker. The series of brown spots on each side of the body are the breathing holes. The grub usually remains in a curved posture.

The eggs being deposited inside farmyard manure heaps, under rotting straw, inside rotting palm stems and in similar other situations the young grubs on hatching find themselves surrounded by plenty of food. They feed on these substances and grow. The grubs under observation took about three to four and a half months to become fullgrown. In the laboratory the grubs were fed on rotting paddy straw only. They lived and fed happily among this stuff covered with moist earth in glass troughs with wire-gauze covers.

The Pupa.

The pupa is yellow-brown in colour. It is found under deeper layers at the places where the grubs feed. The pupa of a fully developed grub measures about two inches in length and about one inch from side to side. Frequently however and especially in the case of the grubs fed under artificial conditions it is smaller in size. The distinction between male and female pupa has already been given. The pupal life has been observed to last for 16 to 18 days in the hot weather and 34 days in November to January.

The pupa produces a hissing sound by moving the segments in the hinder part of the body.

The Beetle.

The beetle is dark-brown in colour, usually with a long or short horn on the head. Just when it casts off the pupal skin its limbs are soft, the colour is pale yellow and the hard wings which cover the back take a little time to develop. In about three days however all the limbs are properly developed and hardened, the colour changes to dark brown and the beetle is able to fly, feed and perform all the functions of adult life. It however frequently rests in the pupal cell for a varying number of days before issuing out. Why it does so is not known.

The size varies a good deal. The largest specimen in the Mandalay collection, a female, measures $1\frac{7}{8}$ inch in length from the front of the head to the tip of the hind end, is $\frac{13}{16}$ inch from side to side and has a horn $\frac{3}{16}$ inch long. The measurements of the same parts for the smallest specimen, also a female are $1\frac{1}{4}$ inch, $\frac{5}{8}$ inch and $\frac{1}{2}$ inch respectively. The longest horn in the males of the collection is $\frac{7}{16}$ inch and the shortest $\frac{1}{10}$ inch. In the case of the females the longest horn is $\frac{3}{16}$ inch and the shortest $\frac{1}{12}$ inch.

The injurious activities of the beetle have already been indicated above. It shuns daylight and in the majority of cases passes the day in hiding in holes at the tops of coconut and other palm trees. While there it continues to bore and feed during the day as has been observed in the cages in the laboratory and also at the tops of young coconut and palmyra palms. The beetles are also found hiding inside the rotting mass in dead palm stems whether standing or lying on the ground, in farmyard manure heaps, rotting straw, etc. At night however all issue out and fly. In the laboratory all beetles attempted to escape from the cages at night.

None of these different situations where the beetles come to hide seems to be sufficiently attractive to be used as traps. The beetles spread and do not congregate at one place. The largest number found in a dead tree was 9 and that in a farmyard heap 8. In these two cases at least some of the beetles had pupated here and did not yet commence active life. In the numerous breeding places searched usually one or two and seldom more than three have been found in individual situations.

Ordinary lights, even bright strong ones, have no attraction for the beetles. The writer had occasion to use a powerful Storm-King gasolene lantern giving a bright white light for about 20 nights in the infested places but did not obtain a single beetle. On the 3rd June 1922 at Pyinmana eight beetles (males and females) captured the same afternoon were placed out in the compound after night-fall and a brightly

burning gasolene lantern hung up on a tree at a short distance. The beetles walked about and the first one took wing after about half an hour but it flew directly away from the light. The light did not seem to have any attraction for any of them. Occasionally however a beetle on wing may be influenced by lights. The writer on two occasions at Pusa while walking on road with lantern got two beetles which fell with a thud near the light.

Mating apparently takes place anywhere and any time during the day and night as will appear from the following observation. Twenty-eight beetles, 18 females and 10 males, collected in Thatôn District between 23rd and 25th March were kept with moist earth in an earthern pot. On opening the pot on arrival at Mandalay on 28th March at 5-30 p. m. a pair was observed coupling. They did not mind being taken up with hand and were placed on moist earth in a jar at 5-47. At 5-49 the female began burrowing into the earth and the couple separated. All this time the male was on the back of the female and quite passive.

The beetles live quite a long time. How they were kept in the laboratory has been described under the section on the egg. They fed by boring into pieces of coconut leafstalk. The maximum period of life observed in the case of a female was 6½ months and in that of a male 6 months. The majority lived for 3 to 4 months, while some died even within a fortnight.

The male produces a low creaking sound by rubbing the hind end againgst the edges of the hard wing covers on the back.

Coconut Beetles and Diseases of Palms.

Several diseases of palm trees of fungal and bacterial origin are known and have been studied in different countries.

The bud rots are the most dangerous and most incurable of these diseases. They attack and destroy the growing bud or heart at the apex of the stem and the trees die sooner or later. In the Godaveri Delta in Madras a serious form of bud rot attacks the palmyra, the coconut and the betel-nut palms and considerable amount of money has been spent in trying to check it by destroying with fire the tops of affected trees so as to remove the sources of infection. Rhinoceros beetles and red weevils have been proved to spread this disease, in addition to other agents, *viz.*, tappers, birds and wind. Therefore checking these insects is considered as one of the methods of checking the spread of the disease.

According to Morstatt (1920) typical coconut bud rot is due to the attack of healthy uninjured palm by a bacillus that is favoured by soil conditions and injury due to insects and is probably spread by the latter. Secondary bud rot depends entirely on a previous disease or injury without which it cannot occur. The injury due to the rhinoceros beetle prepares the way for it. Either one or both the forms may occur in a country. In East Africa a primary independent bud rot and a secondary form due to the rhinoceros beetle are said to occur. In Samoa only the secondary form is said to be present (Rev. Ap. Ent. Ser. A IX, 105). Nothing is known about this in Burma.

The Red Ring or Root Disease of coconut palms prevalent in the West Indies is believed to be caused by a Nematode and to be communicable from one tree to another. Scavenging insects and palm weevils (and also palm beetles which are very readily attracted to decomposing trees for oviposition) are considered to be the means of transmitting living Nematodes or eggs from dead or dying trees Prompt destruction of infested trees is advised.

The date palm disease known as " Doud " is considered to be due to the lesions caused by *Oryctes bispinosus* and another beetle. The disease may be the direct result of injury or due to secondary infection of a bacterial nature (Rev. Ap. Ent. X, 288.)

The Rhinoceros Beetles in other Countries.

The popular name is given to the beetle on account of the presence of the horn on the front of the head like the horn of the rhinoceros. Different species, all however allied and with similar habits, occur in different countries. The various species recorded as rhinoceros beetles in different countries are listed below with the place where they occur. The common Burma species is *Oryctes rhinoceros*, L.

Oryctes rhinoceros, L.—India, Ceylon, Burma, the Straits Settlements, the Federated Malay States, Siam, Annam, Dutch East Indies, Java, Singapore, Sumatra, Celebes, Seram, Ambyona, Texas, Samoa, Seychelles, Formosa, Korea, Hongkong and Philippine Islands.

O. nudicauda—recorded from Minhla, Burma (Comotto, 1881-2) but is apparently rare.

O. dersertorum, Arrow.—India, Persia, Arabia.

O. elegans, Prell.—Mesopotamia.

O. preussi, Kolbe.—South Sea Islands, New Guinea.

O. cristatus, Snell.—East Africa.
O. monoceros, Ol.—East Africa, Zanzibar, Congo, Kenya.
O. Boas, F.—East Africa, Zanzibar, Congo.
O. owariensis, P. de. B.—West Africa, Congo.
O. nascicornis, L —Turkestan, Java, North West India, South and South-East Europe.
O. trituberculatus.—Dutch East Indies.
O. grypus.—Morocco.
O. bispinosus.—Algeria.
O. augias, Ol., *O. colonicus* Coq., *O. insularis*, Coq., *O. pyrrhus*, Burm., *O ranavalo*, Coq., and *O. sinnar*, Coq.,—Madagascar
Archon centaurus, F.—Gold Coast.
Strategus aloeus, L.—West Indies, British Guiana.
S. anachoreta.—Trinidad.
S. quadrifoveatus.—West Indies, Porto Rico.
S. titanus, F.—West Indies, Jamaica, Cuba.
Trichogomphus semilinka, Rtz.—Solomon Island. Froggatt calls this the Solomon Island rhinoceros beetle and says that it feeds in the same way as the elephant-beetle. Three species of *Trichogomphus* are recorded from Burma but nothing is known about their habits.
Camelonotus quadrituber, *Oryctoderes latitarsis*, four species of *Pimelopus* and three species of *Scapannes*.—New Guinea.

It will appear therefore that many countries have to contend against the palm beetle. There have been various recommendations and trials made to control it. In some countries legislation has been resorted to for enforcing control measures and heavy expenses incurred to suppress the pest.

Control Measures recommended and Practised.

The control measures aim at diminishing the number of the insect and those in use among the people or recommended by scientific observers are enumerated below.

1. To deprive the insect of its breeding places—
   (*a*) by clearing all rubbish and refuse heaps or burying such refuse under 8 inches sand ;
   (*b*) by removing all dying or dead palm trees which are burnt or buried underground at a depth of not less than 3 feet or buried and covered under 8 inches of sand or cut into about 3 feet lengths which are split into four pieces longitudinally and left in dry places. The trees are recommended to be cut

low and covered with 8 inches of sand. Burkill recommends the use of explosives in disposing of tree stumps and says that four cartilages of blasting gelatine are sufficient for each tree. Logs used in making bridges are recommended to be stripped of the bark and their ends protected with tin and such bridges are recommended to be renewed after about nine months.

2. To search for beetles, grubs, etc., systematically in their breeding places and destroy them. In some countries large sums have been spent in this operation.

3. To use grub traps. Artificial pits are kept filled with decomposing vegetable matter to which beetles come for depositing eggs. At intervals the grubs, etc., found in them are killed either by turning over the heaps or fumigating them with carbon bisulphide or impregnating them with a poison, such as paris green or lead arsenate. In scrupulously clean localities where the beetle finds no other breeding places trap heaps are very successful. It is reported by Leefmans from the Dutch East Indies that in a garden cleared of all breeding places grub traps reduced the number of the beetles by 74 per cent.

4. To attack the grubs in their breeding places through other means, *viz* :—

(*a*) by impregnating the food with a poison, such as sodium arsenate ;

(*b*) by infecting them with a parasitic fungus, *Metarrhizium anisopliae*. Much was expected of this fungus and various trials were made with it in different countries but without encouraging results;

(*c*) by introducing parasites ; more than one species of Scoliid wasps are recorded to be parasitic on these and allied grubs. But up till now they have not been reported to act as appreciable checks anywhere. For practical purposes, *Oryctes* grubs may be said to be immune against parasites ;

(*d*) by keeping and inducing predating enemies, such as pigs and fowls to prey upon the grubs. Dr. Friederichs states that in Samoa the semi-wild pigs kept by natives are one of the natural enemies and the Commission of Enquiry concerning Coconut Beetles in Samoa (1916), recommends making use of pigs on a large scale.

5. To prevent the beetle from being able to bore into the stem : —

(*a*) by filling the angles of the leaves with sand or sand

and arsenic. This does not protect the cabbage and arsenic is injurious to the tree ;

(*b*) by treating the crown with tar and petroleum ; (The treatment injures the young bud.)

(*c*) by dusting the crown with Paris Green with the idea of poisoning the beetle. It is hardly of use as the beetle does not eat the fibres and it chews internal fibres which are out of reach of the poison ;

6. To decoy the flying beetle :—

(*a*) by means of light traps or brightly burning torches ;

(*b*) with substances having an attractive smell, such as fermenting toddy, fermenting rape or mustard cake or fermenting rice water kept in wide-mouthed vessels among the trees ;

(*c*) by growing alternative food plants, such as wild palms in the neighbourhood.

7. To treat the affected trees so as to cure them : First of all it is necessary to kill any beetle or beetles which may be inside the stem. Application of carbon bisulphide or kerosene oil injures the tree. In different places people pour sand or salt and sand or salt water.

Of the measures enumerated above legislation enforces the first two in some countries. As a matter of fact these two and under certain circumstances also the third measure are really efficacious when properly carried out. After visiting the Philippine Islands, Cochin China, Cambodia, Siam, Singapore, the Malay States, Ceylon and Madagascar, K. Friederichs who had studied the pest very carefully in Samoa, came to the conclusion that clean cultivation and the destruction of breeding places are the essential remedial measures in combating the palm beetle. Where this work is neglected even the natural enemies which include birds, rodents, Scoliid wasps and the fungus *Metarrhizium anisopliae* are not of much use in keeping down the numbers. (Rev. App. Ent., 1920, VIII, page 275.)

Legislation in force in some countries to check the Rhinoceros Beetle or prevent its introduction.

Straits Settlements.—The first legislative enactment against the rhinoceros beetle was in the Straits Settlements (Ordinance No. IV of 1890, amended in 1895). It is given by

Copeland *in extenso* in *The Coconut*. It enjoins the owner to uproot every coconut tree, dead or attacked by the beetle and either to consume it with fire or to bury it in the ground at a depth of not less than 3 feet or to keep it completely submerged in water. Similarly it is enjoined to remove from the premises and destroy dead coconut trees or stumps of coconut timber, rubbish heaps or other accumulations of dung, vegetable refuse or other matter likely to harbour or become breeding places for the beetles. Neglect or refusal to carry out these duties renders the owner liable to a fine varying up to twenty-five dollars. The work is carried out by Government and the cost recovered from the defaulter in the Court of Requests.

Various officials are given authority to have access to lands and trees for inspection. Provision is made for payment of compensation out of public funds to indigent owners, at the discretion of the Governor.

Federated Malay States.—Copeland mentions Enactment IV of 1898 in which similar provisions are made as in the Straits Settlements but all responsibility is vested upon the Government inspecting staff employed for the purpose. Agricultural Pests Enactment No. 13 of 1913, also has practically the same provisions, the owner being required (1) to clean his trees of beetles within one month of notice being served upon him, (2) to uproot and burn or bury below 3 feet, trees which are dead or attacked beyond recovery by the rhinoceros beetle (*O. rhinoceros*) or the weevil (*Rhynchophorus ferrugineus* and (3) to destroy all breeding places ; or the work is done at his expense. No compensation can be claimed for any loss caused by the application of the enactment but needy owners may be given compensation for trees ordered to be destroyed at the discretion of the authorities.

Samoa.—Oryctes rhinoceros, is believed to have been introduced into this island about the year 1909 in earth with rubber stumps brought from Ceylon. Its existence was detected on November 4th, 1910, near Apia, the port of entry. Very vigorous measures were adopted to check it. The proclamations and ordinances resorted to are referred to in the following quotation from a paper by Burkill (Gardens Bull. Straits Settlements, Singapore, I No. 6, December 1913) :—

" On the 8th November 1910 the Government of Samoa issued a proclamation in vernacular to the effect that the beetles and their grubs should be collected, and promising a reward of one mark (36 cents) for every twenty beetles and the

same for every fifty grubs. Seventeen days latter a law was promulgated stopping coconut planting, ordering the cleaning up of all existing plantations, forbidding the using of coconut trunks for bridges and pig-styes and arranging for inspections. About £2,000 was the cost of this method of dealing with the pest up to the end of January 1912, and yet no satisfactory impression had been made on its numbers. Therefore on the first of February 1912, it was made compulsory to search for and destroy the insect. Following this there was issued on April 19th, 1912, a decree calling into being a commission with power to inspect and compel owners of coconuts to keep their estates clean, and to remove structures made of coconut trunks, or standing dead trees, at the owner's expense. Then on the 10th of May 1912, appeared an order requiring all able-bodied persons in the affected districts to turn out at six o'clock on every Wednesday to search for beetles and grubs, which were to be brought to the village headman, counted and destroyed by fire or hot water. Into this great holocaust passed the grubs of beetles which happen to be similar to those of *Oryctes*. Friederichs names them specifically : but their number is a matter for estimation. From the 1st of April 1912, to the 31st of March 1913, roughly, ten million grubs and a quarter of a million beetles were collected and killed on the island of Upolu ; allowing for the grubs of the similar beetles, Friederichs puts down the *Oryctes* larvae destroyed as six million and the beetles as two hundred thousand, a nice little family originating in a few grubs imported in 1910 or possibly 1909.

To this figure has yet to be added the number of the grubs and beetles collected on the European plantations. On the estate of the Deutsche Handels-und Plantagen-Gesellschaft der Sudsee-Inseln zu Hamburg over the same period were collected and destroyed about 350,000 grubs and 23,200 beetles. Further, the number of insects trapped by the commission over the same period was 180,000 eggs, 776,000 grubs, 220 pupae, and 11,300 beetles."

Samoa came into British possession in 1914. The British Military Occupation of Samoa Proclamation No. 6, 1914, prohibits new planting or cultivation without permission in writing of the Inspector, appointed by the coconut beetle commission. Such permission is only to be given subject to the burning and destruction of all dead wood likely to provide breeding places for the insect. Proclamation No. 19 of 1915 orders that all labourers employed upon any plantation shall devote the working hours of the forenoon of every Monday

exclusively to the search and destruction of all stages of the coconut beetle throughout the whole of the infested portions of their land and a return shall be rendered to the Inspector by the owner showing the result of the search. The owner is held personally responsible for carrying out these measures. Contravention of these proclamations entails a fine.

Ceylon.—Regulations under the Insect Pest and Quarantine Ordinance No. 5 of 1901 require the owner to uproot and burn or completely submerge in water all dead coconut trees and to destroy living trees attacked by the rhinoceros beetle (*Oryctes rhinoceros*) or the red weevil (*Rhynchophorus ferrugineus*) or cut the portions attacked with the contained beetles, eggs and larvae and fill up the cavity with mortar, etc. Keeping of matter likely to shelter beetles is prohibited and also of dead coconut stems unless sawn into rafters for building. No manure may be left unused longer than four months.

The Plant Pests Ordinance No. 6 of 190- sets up Plant Pests Boards with powers to require owners to carry out instructions regarding treatment or do it at owner's expense. All fallen and dead coconut trees are required to be burnt, unsplit coconut stems more than 12 months old to be removed from fences and unsplit coconut stems prevented from being further used in fences.

British East Africa.—The Coconut Beetle Ordinance of 1909 never came into force. The East Africa Protectorate Coconut Preservation Ordinance, 1915, was passed as a result of the investigation by the commission appointed in 1914. It provides for the inspection of all coconut growing lands. All trees dying or dead or attacked by insects (*Oryctes rhinoceros*, *O. boas* and *O. cristatus* are recorded as the rhinoceros beetles here) are required to be dealt with according to the direction of the inspector. Refuse heaps, dead coconut stems, etc . are required to be destroyed. Neglect or refusal on the part of the owner to carry out these measures entails a fine. The Governor in Council has power to make regulations regarding the construction of pit-traps for the beetles. The Governor may make such compensation as he thinks fit for trees ordered to be destroyed.

Zanzibar.—The Plantations Preservation Decree No 4 of 1913, provides for the destruction and disposal of dying, dead and infested trees and decaying vegetable heaps. An Inspector may enter any land and give orders for carrying out these meaures or carry them out at the owner's expense. Compensations for trees destroyed may be paid according to the direction of the authorities.

British Guiana.—Under an ordinance to prevent and suppress diseases of plants and plant pests (1914), the Board of Agriculture has authority for inspection and treatment of diseases and pests among which the rhinoceros beetle (*Strategus aloeus*) is included. Orders have been issued for felling, dying and dead palms and for burning or burying them.

Trinidad and Tabago.—Plant Protection Ordinances are in force for the past several years and take notice of the rhinoceros beetle (*Strategus aleous*) and the palm weevil or the gru-gru worm (*Rhynchophorus palmarum*).

Seychelles.—A bill is reported to have been prepared (1919) giving power to the Agricultural Department to eradicate the coconut beetle (*Oryctes rhinoceros*) at the expense of the owner from plantations not properly looked after and also to deal with the breeding places (Rev. Ap. Ent. Ser. A. VII. P. 483).

Nyasaland.—Coconuts are included among the plants which under the Plant Protection Ordinance No. 16 of 1912, are required when imported to be accompanied by a certificate that they have grown in areas free from diseases and pests.

Tonga.—Provision is made under law for preventing introduction and spread of the rhinoceros beetle.

Fiji.—By a Proclamation, No. 24 of 1913, importation of vegetable matter is prohibited from certain prescribed countries in order to prevent the introduction of the rhinoceros beetle (*O. rhinoceros*) except with special permission, inspection and fumigation.

Natural Checks and Enemies.

Mention has already been made above under the section on control measures recommended and practised, of the existence of fungal diseases and insect parasites on the grubs in some countries. Experiments with them have shown that they are hardly of much use in controlling the pest. In the Philippine Islands a flying lemur (*Galeopithecus* sp.) is recorded to prey upon and destroy the beetles.

More than 700 grubs collected at different times from different infested districts in Burma were under observation in the laboratory. No parasite was observed. There were many deaths owing to the dry hot climate at Mandalay and artificial conditions of rearing, but no special disease could be noticed. When suitable conditions prevailed, for instance, during the moist rainy months there were hardly any deaths in the laboratory. The insect apparently thrives with hardly any

check in Burma. Adverse climatic conditons probably have a little effect on multiplication. For instance, during the rainy season it was observed at Yinnyein village in Thatôn district that many farm yard heaps being soft and muddy breeding was restricted to some extent at this time. At Pyapôn the beetle is said not to occur in the rainy season.

Use of country pigs is recommended in Samoa for the destruction of the grubs. The writer and Mr. Clague tried some country pigs at Yinnyein but they would not even touch the grubs. Grubs thrown out in an open yard before fowls were soon picked up by the latter and crows. None of these birds however searches out the grubs from the breeding places.

In some places in Burma some people eat the grubs as well as the beetles. A Burman labourer at Hmawbi described that the dark hinder part of the grub was rejected and the rest of it eaten either in fried or boiled condition with salt. Nowhere however the grubs are collected and sold for this purpose as some other insects, for instance, crickets, are done at Mandalay. The number disposed of in this manner is apparently very small.

Preventive and Control Measures in Burma.

The measures necessary are to take care of the breeding places so that the beetles may not multiply. Their number will then very soon be reduced. The important breeding places are farm yard manure heaps, dead palm stems and rotten paddy straw.

All farm yard manure heaps, large and small, should be turned over with spade thoroughly whether any insects are found in them or not, at frequent intervals of about two months and never more than about three months at the most. All stages of the insect present in them should be killed by being crushed or cut or picked up and placed in hot water, or fed to fowls or thrown into deep water or buried in a pit not less than 3 feet deep in a hard soil, the pit being closed and thoroughly rammed down. The beetles should invariably be crushed or cut or killed by being placed in hot water. When it is possible to be done all heaps should be cleared off and distributed in the fields as manure.

With a little care these heaps can be converted into grub traps as are reported to be used with succees in Samoa, British East Africa and Dutch East Indies. The plan would be to have as few heaps as possible in the village instead of each household having several indiscriminately located ones as at present and to turn over and search them at short intervals.

Paddy straw, thatching straw, *pyaung* (*Andropogon*) leaves, etc., rejected from cattle sheds should not be added to the farm yard manure heaps but should be kept separately and burnt when dry, at least before the rains commence.

Paddy straw for use as fodder should be stacked on a raised platform whether of earth or wooden or bamboo framework so that it may not soak water at the bottom and rot. Similarly, care should be taken by better stacking or providing cover, so that the straw may not soak water at the top and rot. No paddy straw should be allowed to lie about here and there and rot in the rainy season.

As soon as a coconut tree is sufficiently damaged, that is when its heart shoot and leaves are killed and it ceases to put forth any fresh leaves or flowering shoot it should be considered to have changed from a useful tree into a source of danger to other trees belonging to its owner and others and should be ruthlessly disposed of. The tree should be uprooted, cut into suitable lengths and either split into thin pieces, dried and used as fuel or thrown into deep water or buried under ground at a depth of 3 feet at the least. On no account should a dead palm stem (including palmyra, talipot and betelnut palm) or even a part of it, should be left standing or lying about on the ground.

The above are the essential measures necessary to be carried out over the whole infested area in order to be able to bring the pest under control and to keep it under control. If the carrying out of these measures cannot be ensured through persuasion or executive orders the circumstances demand that there should be no hesitation in resorting to legislation for enforcing them.

The writer and Mr. Clague visited Yinnyein and Theinzeik in Thatôn district in March 1921, when the school boys and residents of these villages were got together, shown the insects present in farm yard manure heaps and explained how damage to coconuts could be prevented. Mr. Clague arranged to place Maung Po Su, District Agriculturist, to get the people to turn over their farm yard manure heaps in some villages in the Thatôn district. Mr. Shwe Zan Aung, Deputy Commissioner, called together the thugyis and gave them lithographed instructions regarding the measures to be carried out. Maung Po Su carried out the work for a short time and reported that he had destroyed 2,236 grubs, pupae and beetles. He gave it as his opinion that the work was not done satisfactorily and it would not be carried out satisfactorily unless there was somebody to see to it being done with threats of penalty in case of failure to comply with the instructions.

It may be mentioned here that the writer during his three visits to the Yinnyein village in March, August and December 1921, collected from the farm yard manure and straw heaps and disposed of about 1200 of the insect in different stages. Some more were destroyed by the efforts of Mr. Shwe Zan Aung and Maung Po Su. The result was that the thugyis and residents of this village reported less attack during the year although the work was by no means systematically carried out.

It would appear that in order to be able to combat the pest a good deal of propaganda is necessary to educate the people in the working and habits of the insect and it may be necessary to resort to legislation for enforcing the preventive measures. The educative propaganda is expected to disarm opposition to legislation. The plan of the educative propaganda would be the following:—

As more vigorous measures are required in the infested area in Lower Burma than in Upper Burma, the posters should be distributed as widely as possible in Lower Burma, so that they may be on view in all public places, such as offices, courts, and police-stations, at all railway and steamer stations, and in each village. The whole area comprising the Arakan Division and all the districts south of and including Minbu, Magwe and Yamèthin districts and southern part of the Southern Shan States, should be formed into convenient circles, in each of which a man will be placed. His work will be to visit all the villages in his circle at least once in three months and have all the breeding places treated or destroyed as necessary. He will at the same time have an opportunity of talking to the people about the pest. The farm yard manure heaps will be turned over probably easily but there may be some opposition to cutting down trees, although there should not be such opposition as the owners always know the trees which are irretrievably spoilt. Some pressure therefore may be necessary in the absence of a legislation. For the rest of the province, it will be enough if the posters are on view in public places and at railway and steamer stations and the leaflet distributed liberally.

The above measures may be supplemented by destroying the beetles which may be found at the tops of the trees. The only thing possible is to probe the holes with a pliable telegraph wire or even a pointed bamboo stick. If the beetle is pricked and injured it dies. It is advisable to plug the hole with sand and clay so that the red weevil, rain water, etc., may not have access into it. It is frequently not easy to collect the beetles

from the trees without widening the hole bored by the beetle and therefore inflicting further injury to the tree. Besides men are not always procurable to climb the trees especially during the rainy season when the stems are wet and slippery. Spasmodic efforts at collecting beetles from the tops of trees are often made by the owners. For instance, at Thayetmyo the *chetties* (money-lenders) pay four annas for each beetle extracted from their trees and are reported to have paid up to Rs. 25 at a time. Owners in Pyinmana pay one to two annas for each beetle extracted from their trees. In the Noakhali plantation at Akyab men are regularly employed to extract the beetles from the trees. The manager reported in 1922, that their efforts were not successful because no attention was paid to the beetle in the neighbouring villages. In August 1921, the writer declared a price of 1 anna for each living beetle at Yinnyein without receiving a single specimen.

The Elephant Beetle. The grubs (fig. 2) found in dung heaps, rotten straw, etc., hatch from eggs (fig. 1) laid by the beetle (fig. 3). The grubs pass through the pupa stage (like the grubs of the Rhinoceros Beetle) to turn into beetles. Fig. 3 is a female beetle and figs. 4 and 5 are males showing difference in the development of the horns. The egg is oval in shape when laid, increasing in size and becoming almost round before hatching.

THE ELEPHANT BEETLE (*Plate V*).

(*Xylotrupes gideon*, L.)

On account of the peculiar processes or horns on the thorax and the head of the male, looking when highly developed like a pair of curved tongs, this beetle is popularly called the "elephant beetle." It occurs in India, Burma, the Federated Malay States, Dutch East Indies, Indo-China, Queensland, New Guinea, New Zealand, Solomon Islands and the Philippines. It is curious that hitherto it has not been recorded from Burma where it is widely spread and is present throughout the year. In some localities in Burma where it occurs in large numbers and where the rhinoceros beetle has not yet been observed, for instance, Konzaung in the Môn canals area in Minbu district, the experience of the people is that these beetles attack coconuts only in the hot weather commencing from about March. At other times in the year they are found on other plants, especially lady's fingers (*Hibiscus esculentus*) of which they eat the pods. It may be stated that coconut cultivation has been undertaken here within about the last ten years after the opening of the canals. The damage to the coconut takes the following form. The leafstalks are bored and gnawed across or along their length to some extent causing them frequently to break at the place attacked. The central unopened leaves are eaten or gnawed in the stalk causing them to break very often or exhibit trimming and punching on opening. Although the leafstalks are in some cases bored down to the base the beetles have not been observed to enter the stem. Therefore the trees are not killed as is done by the rhinoceros beetle, but the activities of the elephant beetle give them a very ragged appearance (*see* Plate VI).

In other countries where it occurs the elephant beetle is recorded as a pest of the coconut. Froggatt says that this beetle bores into the bases of the leafstalk, thence into the base of the crown of the palm where, if not checked, it will kill the terminal bud and destroy the tree. It has been recorded by more than one observer to infest the tender leaves at the crown of the coconut in Java. Burkill records it in the stem of Pinanga palm in the Straits Settlements The elephant beetle is known to feed on many other plants besides coconut. The writer found many beetles on lady's fingers (*Hibiscus esculentus*) at Konzaung at the end of November. They fed voraciously on green lady's finger pods in the laboratory. At the same place they were also found on *Kasaw-bin* (*Cassia Sophera*) which grew wild in the jungle and of which the bark

seemed to be nibbled. The people report that the beetles are found on lady's fingers throughout the rains and winter and some times also on *Kon-ya-si-bin* or *Mya Sein* (*Parkinsonia aculeata*). In September a male was found feeding on bean leaves at Maymyo. Keuchenius records this beetle as abundant on *Murraya exotica* and *Poinciana regia* and to feed on the latex of hevea. Beeson found it on *Poinciana regia* in India, and Girault and Dodd on the same plant in Queensland. At Tezpur in Assam it has been observed damaging seed indigo plants by gnawing and stripping the bark (Proc. Third Ent. Meeting, Pusa, 181). Green has recorded it feeding on the foliage of *hevea* rubber in the Federated Malay States. It is also said to feed on the juice of damaged sugar cane and some times to gnaw the cane.

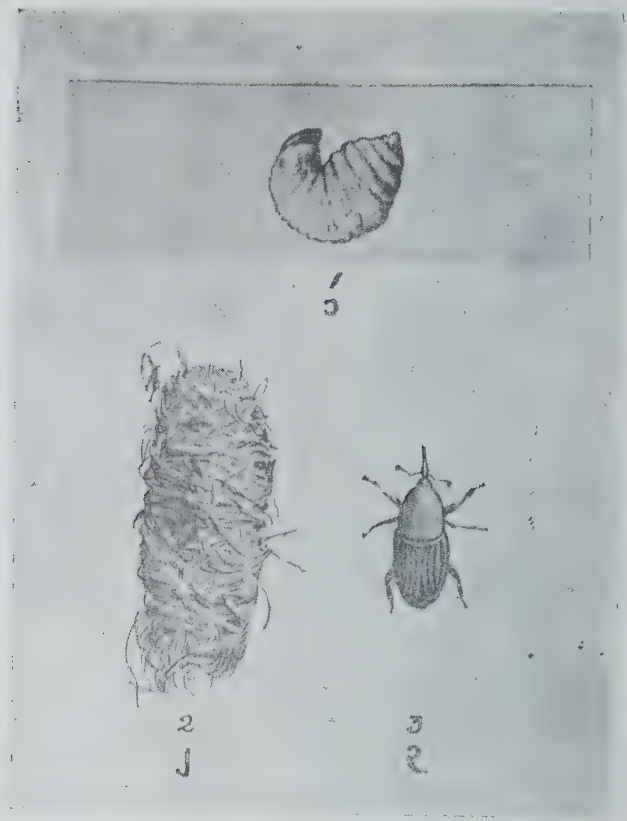
The life history of the elephant beetle is similar to that of the rhinoceros beetle. The breeding places are apparently the same, *viz.*, dung heaps and decomposing straw, etc. At Konzaung large numbers of the grubs were found under rotting straw at the end of November. The beetles laid eggs among rotting straw and rotten cattle dung in the laboratory in December. The periods of the stages are however not known yet. According to Girault and Dodd the whole life-cycle takes more than a year in Queensland, the pupal stage lasting less than seven weeks and being found between November and February. As far as can be made out in Burma the period of the life-cycle seems to be much shorter and breeding seems to be continuous and the broods overlapping as in the case of the rhinoceros beetle.

According to Leefmans, the grubs of this beetle injure the roots of the coconut and also of sugarcane and cassava in the Dutch East Indies. They are included among the cane-infesting grubs in Queensland. Recently a grub (apparently of this beetle which is still under rearing) has been sent in from Magwe as infesting groundnut under soil when the rain fall is scanty. All past records however show that the grubs habitually feed on decomposing vegetable matter in the soil and in Java, removal of decomposing rubbish has been considered useful against this beetle.

It would therefore appear that the measures recommended against the rhinoceros beetle are fully applicable against this pest too.

It may be possible to get at the beetle itself easily as generally it does not bore down very deep. Besides it is found some times in numbers on lady's finger, *kasaw bin* (*Cassia Sophera*) and other plants. Wherever present it should be collected and destroyed and never spared.

Coconut leaves damaged by the Elephant Beetle.



The Red Weevil. The grubs (fig. 1) hatch from eggs (not shown) laid by the weevil (fig. 3). The grubs pass through the sleeping pupa stage inside cocoons (fig. 2) of twisted fibres before attaining the weevil stage (fig. 3).

THE RED WEEVIL (*Plate VII*).

(*Rhynchophorus ferrugineus*, Oliv.)

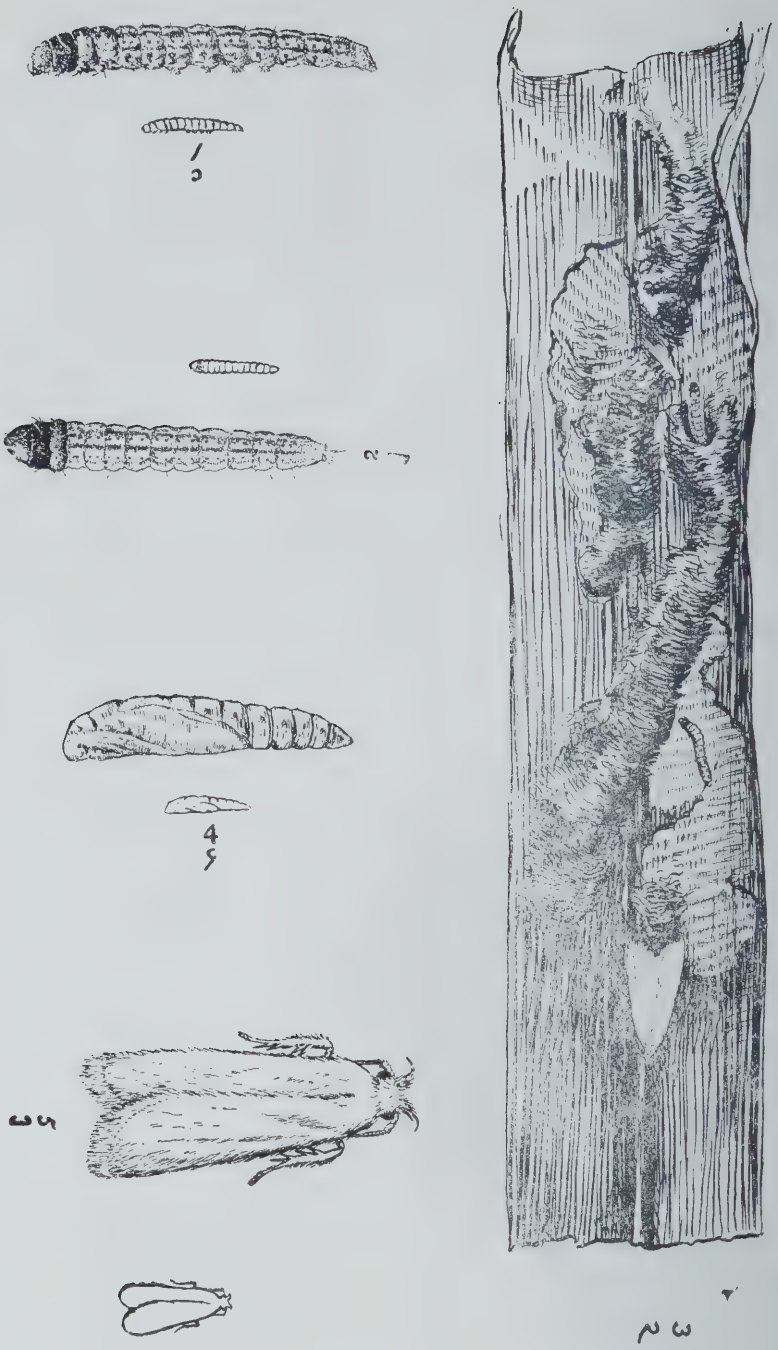
The adult weevil (Pate VII, fig. 3 and 4) is a longish flattened insect having a long snout and red-brown colour with or without black spots on the upper surface. It is known to some people in places where it occurs. It is abundant at Pyinmana and also in Lower Burma where it is said to breed in *taw-kun* (*Pinanga gracilis*). As it lives in hiding and flies little it attracts less attention than the rhinoceros beetle. The weevil itself is incapable of doing any damage by feeding as is done by the rhinoceros beetle. It however seeks fresh living tissue to feed and deposit its eggs as the young require fresh palm tissue for food. The holes bored by the rhinoceros beetle afford easy access into such tissue at the very heart of the tree. Here it finds food as well as an ideal place for laying eggs. It takes full advantage of it and lays a good many eggs, as many as a hundred or even many more. The resultant grubs bore the crown all round and also down the stem and hasten the death of the tree. The weevil however may attack the tree anywhere, independently of the rhinoceros beetle, such as at the base or the middle of the stem if it finds suitable means of entrance or of oviposition. The holes gnawed by the elephant beetle in and at the bases of the leafstalks are vulnerable points where the attack of the weevil may commence. The trees when attacked by the weevil fare worse than at the hands of the rhinoceros beetle and are killed more quickly. But the weevil does not cause such wide spread damage as the latter. The weevil is known to live for two to three months during which period the female is capable of laying about 300 eggs. The eggs hatch in about four days in ordinary temperature. The shortest period during which the grub can grow to full size (Plate VII, fig. 1) is about a month. The full grown grub pupates in the affected stem inside an oval cocoon made by twisting the fibres (Plate VII, fig. 2). The whole pupal life inside the cocoon takes about three weeks. The adult weevil commences laying eggs soon after issuing from the cocoon. Therefore there may be fresh generations after every two months or so.

What usually happens is that when the weevil has access into fresh tissue it continues to live there and goes on depositing eggs for a number of days. This is why numerous grubs are found inside the same tree, which quickly succumbs to their attack. The weevil flies at night.

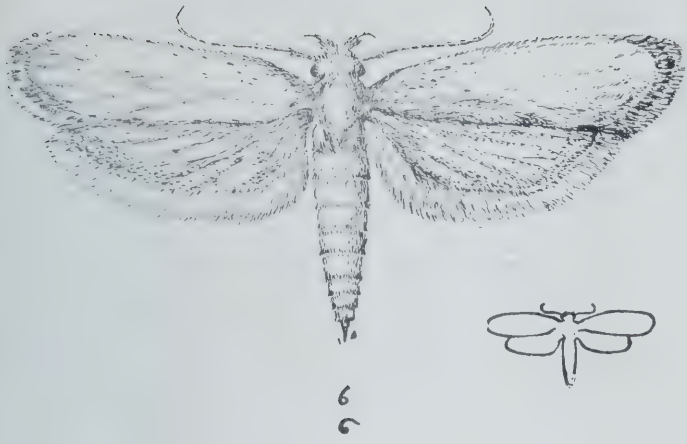
The palm weevil is practically as widely distributed as the rhinoceros beetle (*O. rhinoceros*) and has its representatives in Africa, West Indies and America. The food plants also are practically the same.

As the affected trees form the breeding places it is evident that if the control and preventive measures against the rhinoceros beetle are carefully carried out, they check the palm weevil also effectively. The legislation wherever in force against the former includes the palm weevil too.

The grubs are eaten by Burmans in boiled or fried condition and are said to have a taste like that of boiled coconut milk.



The leaf-nibbling caterpillars (figs. 1 and 2) nibble the surface of the leaf (fig. 3) and live under webbings formed on the nibbled surface. Later on they turn into pupa (fig. 4) and ultimately come out as moth (fig. 5, sitting posture and fig. 6, flying posture). The moth lays eggs from which caterpillars hatch. The smaller figures show natural sizes.



The moth of the leaf-nibbling caterpillar in flying posture.

THE PALM LEAF-NIBBLING CATERPILLAR

(*Plate VIII-IX.*)

(*Nephantis serinopa*, Meyr.)

These caterpillars nibble the surface of the leaves. As a result of their feeding, the leaves dry. The attack commences from the lower leaves and gradually spreads to the upper ones. The pest is very active in the rainy season. In cases of bad infestation the trees are considerably weakened and succumb more quickly to the attacks of the rhinoceros beetle and the red weevil. The caterpillars alone however seldom prove fatal unless the attack is repeated in serious form year after year.

The pest passes its whole life on the plant. Eggs are very small and are laid on the leaves in crevices and furrows near the midrib. A single female lays about 200 eggs. The caterpillars (Plate VIII, figs. 1 and 2) which hatch from them feed by nibbling the leaf tissue and live hiding under webbings of their own excreta and dry chewed bits of leaf (Plate VIII, fig. 3). When full grown they pupate inside these webbings. The pupa (Plate VIII, figs. 4) is brown and from it the moth (Plates VIII-IX figs. 5 and 6) emerges after a few days. The period of the life-cycle is about five weeks from the egg to the adult stage. Fresh broods occur about every five to six weeks.

The pest is present in the whole of Burma and apparently in a worse form in Upper than in Lower Burma. It also occurs in India and Ceylon. In Burma it has been observed to attack the coconut, the palmyra, the betelnut, the wild date and the talipot palms, out of which the first named two suffer most. As the pest is present practically everywhere even on small wild date palms in the waste lands and jungles control measures become very difficult. Spraying with any kind of poison is out of the question. The only effective measure is to cut off and burn the first affected lower leaves. The importance of this measure will be apparent from the fact that a single infested coconut leaf has been observed to harbour up to about 700 caterpillars. The infested leaves therefore become prolific breeding grounds. If all co-operate in this method the pest can be readily controlled. In Travancore in southern India a special staff is temporarily engaged to see this measure being carried out. In Ceylon this insect is declared a pest by a proclamation dated 30th September 1922 under the Plant Pests Ordinance, 1907. Owners and occupiers of coconut plantations on which

any stage of this insect is present are required to burn light traps or defined forms of fires for at least two hours between 7 and 10 p.m. for ten consecutive weeks at the rate of at least three for every acre. The writer's trials with ordinary and gasolene Storm King lanterns in the Mandalay Farm at not very long distances from badly infested trees do not give much hope of success in this method.

APPENDIX!

Since this bulletin was in print a fungus, characterised by the Imperial Mycologist, Pusa, as Penicillium-like, appeared in the laboratory at Mandalay in a lot of *Xylotrupes* grubs collected early in December 1922 at Konzaung in Minbu District and killed off all the grubs. It was not found before either in the laboratory or in the numerous searches carried out among dung heaps, etc., during the last two years. It was tried on more than 300 *Oryctes* grubs in the laboratory on 24th January 1923 and all of them were killed by about 15th February. It was again tried on 20th February on 50 grubs all of which died by 6th March 1923.

The infected grubs die with these symptoms. Their activities cease and on death the colour loses its freshness and changes to yellowish white. The normal shape is retained to a very great extent but the whole body becomes stiff. Very soon a thick white bloom appears all over the body and in the course of a few days changes to dirty green in colour. The dead grubs do not rot (unless they happen to be covered with very wet matter) but gradually crumble away.

In the laboratory during the last two years *Oryctes* grubs have been kept and reared successfully in large glass troughs. Plenty of wet rotting paddy straw, old cowdung and earth are mixed and fill about half to two-thirds of the troughs. The grubs live in this material feeding on the straw and cowdung. In order to keep the material moist care is taken to have always a layer of wet straw on top of it. The troughs are provided with wire-gauze cover.

The fungus appeared in one such trough. The method of inoculation followed in the laboratory trials mentioned above was to take a handful of earth, etc. from this trough and mix with those in the troughs required to be infected. All the grubs (altogether in five lots) infected in the laboratory died with the characteristic symptoms.

A few Holotrichia grubs which went into hibernation soon after inoculation, resisted the fungus in the laboratory.

The fungus was given a trial under natural conditions in two villages in the neighbourhood of Pyinmana. The method of inoculation was as follows :—

A quantity of earth, etc., from the infected troughs in the laboratory was carried in a kerosene tin. Fresh grubs were collected in this tin and they soon barrowed into the infected material. After some time the contents of the tin were emptied and the grubs picked out and placed back in the following three situations with a handful of the infected stuff—

(1) An old coconut stump practically level with the soil in a compound in Shanzu village had 87 almost fullgrown *Oryctes* grubs feeding inside it. Practically the whole pithy part had been converted into a damp black powdery mass, the outer shell of the stump forming a sort of a trough. The grubs were kept for about 15 minutes in the inoculating tin (19th February 1923).

(2) One large mass of decomposing cowdung heaped up in an open place under but hardly shaded by a tree in Ywagauk Village. Some *Oryctes* grubs were present in it. About one hundred full-

grown as well as younger grubs, were added from the inoculating tin in which they had remained for about one-half to twenty hours. A quantity of wet straw was provided to the inoculated grubs and some infected stuff from the tin was spread over the entire heap. The heap was well covered by drawing up cowdung from the edges (18th Febrnary 1923).

(3) One dung heap having fresh and decomposing cowdung, paddy straw, etc. The grubs found in it were inoculated in the tin for about half an hour and also some grubs inoculated for about three hours were added. Infected stuff from the tin was mixed in the heap and also a quantity of wet straw placed in it (19th February 1923).

On examination on the 13th March 1923, all the grubs in (1) were found dead with characteristic overgrowth of the dirty green fungus, except one young one about one-third grown. The whole of (2) was searched and the following were obtained—

Four beetles, one pair mating (9 a.m.)
Five pupae, all about the situation where inoculated grubs had been placed and apparently developed from the latter.
Fifteen fullgrown grubs dead with the characteristic overgrowth of the fungus.
One such grub dead without fungus.
Fifty-eight fullgrown live grubs.
Thirty-two younger live grubs.

The following were obtained from (3) :—

Four beetles.
One fullgrown grub, dead with the characteristic fungal overgrowth.
Seventy-one fullgrown or almost fullgrown grubs; some of the inoculated ones had developed.
Thirty-five younger grubs.

This difference in the result was due entirely to the presence or absence of moisture required for the proper development of the fungus. The coconut stump retained moisture and gave the best result. The heap No. (3) was the driest of all and the fungus had no chance. The results of the heap No. (2) were not encouraging. It is not known how the fungus will work in the rainy season. At other times it apparently will not be effective under out-door conditions unless especial grub traps can be set up where the necessary moisture can be maintained. As far as can be made out under the present circumstances the fungus cannot be relied upon as an efficient instrument for fighting the *Oryctes* and *Xylotrupes* grubs.

Fullgrown grubs seem to be more susceptible to the fungus than younger ones.

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Department of Agriculture, Burma

BULLETIN No. 19

THE PALM BEETLES IN BURMA

WITH NOTES ON OTHER PALM PESTS

BY

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ENTOMOLOGIST, MANDALAY

RANGOON

SUPERINTENDENT, GOVERNMENT PRINTING, BURMA

1923

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1923

THE COMMONER GRASSES OF BURMA

WITH

NOTES ON THEIR AGRICULTURAL IMPORTANCE AND DISTRIBUTION.

BY

A. McKERRAL, M.A., B.Sc.

DIRECTOR OF AGRICULTURE, BURMA

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20.

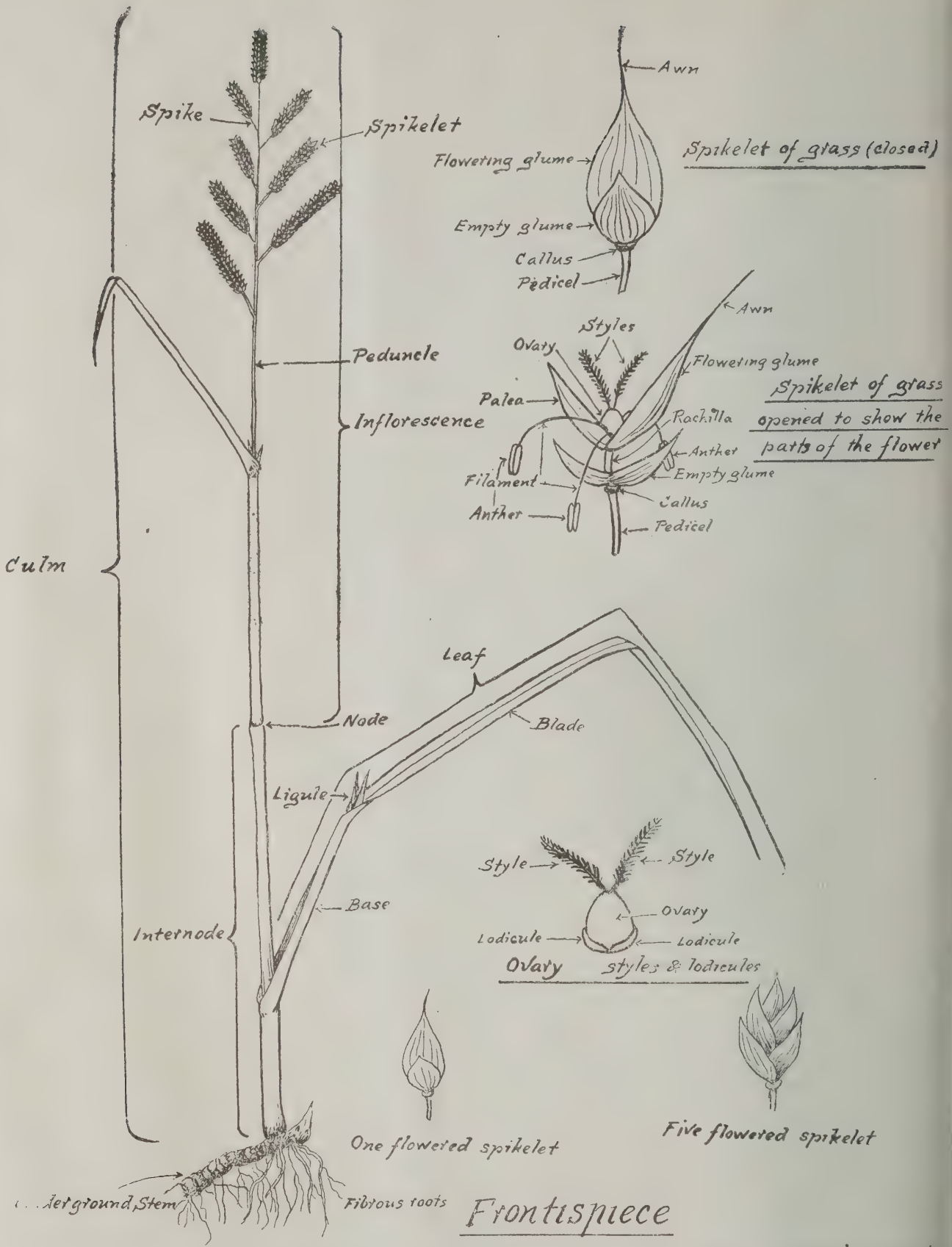
INTRODUCTION.

THE notes on grasses and their distribution in Burma published in this bulletin have been made by the author during his tours for the last five years as Deputy Director of Agriculture. The notes are meant to be agricultural rather than botanical. For those who wish to study the botanical structure of grasses in detail there are available Volume, VII of Hooker's Flora of India and an excellent "Hand book of some South Indian Grasses" by Rai Bahadur K. Ranga Achariyar, published by the Superintendent, Government Press, Madras.

The names of the genera and species given in the Bulletin are the same as those in Hooker's Flora of India.

It is hoped that the notes given in the present bulletin will help to stimulate observation on the part of the younger members of the district staff of the Agricultural Department in Burma and that they will be able as time goes on to add to and if may be to correct the information collected by the author. The identification of the commoner grasses is not a difficult matter and in the case of a fair observer they soon become known at sight. More important than to know them as individuals is to know their distribution and the value put on them by cultivators in various parts of the province.

For the preparation of the plates the author has to thank Messrs. E. M. Sawyer and Whay Ta Yin of the Agricultural Department. His best thanks are also due to various officers of the Botanical Survey of India for assistance in correctly naming certain of the species.



Frontispiece

Drawing of a typical grass plant to show its various parts.

I.—DESCRIPTION OF GRASSES.

Grasses belong to the Natural Order of plants known as Gramineæ. This is, from the economic point of view, by far the most important of the Natural Orders. It includes practically all our cultivated cereals, most of our fodder plants, while the sugarcane plant and bamboos are examples of giant grasses.

The flowering axis or stem of a grass plant is known as the *culm*. At the top of the culm is borne the *inflorescence* or flowering system of the grass. The inflorescence is borne on a stalk called the *peduncle* and has many smaller branches which bear on them the *spikelets*. The latter consist of one or more flowers and are borne on the smallest and final branches of the inflorescence. Spikelets may be borne on a stalk known as the *pedicel*. If no stalk is present the spikelet is said to be *sessile*.

To understand grasses well it is necessary to observe clearly the parts of a spikelet, because it is largely on the difference between these as shown in different species that the classification is based. (*See* Frontispiece.)

If we take a spikelet of any grass and examine it we will find that it consists of a short slender axis called the *Rachilla*. Arranged along the rachilla are modified leaves or bracts which are known as *glumes*. These are often prolonged at their upper ends into *awns*. At their lower ends and at their junction with the rachilla the glumes are sometimes prolonged and thickened into a *callus*. Between the glumes and the axis or rachilla there is another bract usually thin and transparent. This is called the *pale* or *palea*. This bract, however, is frequently absent.

The *flower* of a grass is borne between the glume and the palea when the latter is present. Sometimes no flower occurs within the glume and the latter is then said to be empty or barren.

The flower of a grass may be either perfect or imperfect. In the case of the perfect flower there occur at the base two minute scales called *lodicules*, usually three stamens but sometimes less and sometimes six, and each stamen consists of an *anther* borne on a slender thread or *filament*. There is also a single *ovary* which bears two or very rarely three feathery styles.

Imperfect flowers are male only or female only or neuter, that is neither male nor female. Male flowers have stamens only and female flowers an ovary only.

The spikelets of a grass may be either single flowered or many flowered. As an example of a grass with single flowered spikelets we may take the paddy plant. The spikelet here consists of two small empty glumes at the base of the rachilla and two larger glumes situated above these. One flower only is present in each spikelet.

As an example of a grass with many flowered spikelets we may take Le-gwa or Eleusine indica, in which the spikelets have three to five flowers.

The fruit of a grass is known as a *Caryopsis*. The fruits of a grass are often wrongly called seeds.

The following are some other important terms used in connection with the inflorescence and spikelets of grasses :—

Articulate means jointed, *i.e.* the spikelets jointed on their pedicels.

Imbricate spikelets are those which overlap each other.

Digitate means shaped like the fingers of a hand.

Secund means one sided. Secund spikelets all point to one side.

Auriculate means ear-shaped. Sometimes the glumes have ear-shaped appendages in their upper parts.

Pectinate means like the teeth of a comb. In some grasses, such as Eremochloa the margins of the glumes are so shaped.

Ligule. This is a thin papery-like projection at the top of the leaf sheath.

II.—CLASSIFICATION OF GRASSES.

To study grasses all that is required is a cheap lens and a couple of dissecting needles. The spikelets should be dissected out by the needles in a drop of water on a glass plate and examined by the lens. Elaborate microscopes are not necessary.

After a little practice most of the common grasses can be distinguished at sight when growing in the fields, their general form and growth habit being enough to identify them by.

The order Gramineae is divided into two main groups as follows :—

(*a*) *Panicaceae*.—In this group the spikelets are *articulate* on their pedicels or deciduous with them. The spikelets are one to two flowered only. If two flowered the upper flower alone produces fruit. This is by far the most important of the groups in Burma and India. Example—ordinary Rice or Oryza.

(*b*) *Poaceae*.—In this group the spikelets are continuous, not articulate, on their pedicels. They are one to many flowered, the rachilla is articulate at its base and often between the flowering glumes. The lowest flower always fruits and the upper flowers are often male or neuter. Example—Le-gwa (Eleusine).

The difference between these two groups can best be seen by studying the two examples given throughout their growth period.

Those who wish to study the Grass family carefully must procure and read Volume VII of Hooker's Flora of India. The present list is meant to indicate the main genera of Agricultural importance with hints, in popular language, on how to distinguish them from each other.

A. Panicaceae

Paspalum.

These grasses have spikelets arranged in secund order on simple spikes. The spikelets have three glumes only, are single flowered, and are never awned.

1. **P. scrobiculatum.**—Known by its round or orbicular spikelets arranged on a flat rachis. A giant form is found on the riverine areas. It is often a sign of wet land but on the 'kons' of Lower Burma it is a good fodder grass giving a succulent herbage throughout the rains.

2. **P. sanguinale** and **P. longiflorum** have long lanceolate spikelets. They are found along with P. scrobiculatum on 'Kon' land in Lower Burma and their soft herbage is much appreciated by cattle. (Plate I.)

Eriochloa.

This genus is only distinguishable from Paspalum by having the base of the spikelets thickened to form a callus. Usually this callus is dark coloured. The spikelets are also silky to the touch.

3. **E. polystachya** is a tall grass usually found in damp situations such as along irrigation channels. It is eaten by cattle but as it usually occurs but sparsely it cannot be said to be important agriculturally.

Isachne.

This genus is an exception to the rule that in the Panicaceae the spikelets are deciduous from their pedicels. In Isachne they are not and the spikelet and pedicel fall together. They are also distinguishable by their spikelets being nearly globose or obovoid.

4. **I. millacea** is found on marshy land and on paddy kazins in Lower Burma. There it does not seem to be valued much but in the Yawnghwe

valley of the Southern Shan States, where it is called "myet-wine" it is the most esteemed of all grasses for feeding ponies.

Panicum.

This is one of the largest and most important genera of grasses and is well represented in Burma. The Panicums can be told by their four glumes (of which the first is usually the smallest. The spikelets are never awned except in P. Crus-galli and P. Notabile. The inflorescence is very variable. The following are the principal groups of the genus panicum :—

(*a*) Spikelets in two series close set on the under side of the flat rachis of a simple spike.

5. **P. flavidum.**—An important grass. It is found all over the province and is the principal element of the close turf found on fallow fields in the dry zone. As found there it is usually small and dwarf. It gives a succulent herbage much liked by cattle and sheep. Plate II.

On rich soil with plenty of moisture it is a tall grass up to 3 and 4 feet high.

(*b*) Spikelets 3—4 seriate.

6. **P. Crus-galli.**—This is the only long awned panicum. A semi-aquatic. It occurs in two distinct forms (1) a short awned type sometimes with purplish transverse bars on the leaves and found growing among standing paddy; (2) a tall robust type with long awns and light green foliage found growing in ditches and water channels. Plate III.

P. Crus-galli is regularly cut and fed to cattle in both Lower and Upper Burma.

7. **P colonum.**—Like the above but with no awns. A most important grass. It grows on rich land where there is plenty of moisture but not usually in standing water. Its best growth is achieved on the rich soil of the riverine areas and cow-keepers go long distances to procure it in a pure state for feeding to milking animals. It is considered the best of all grasses for this purpose. A cultivated variety in India is known as Banti. The Burmese name for P. Colonum is Wun-be-sa (duck grass). Plate IV.

8. **P. notabile.**—Found in the dry zone only. Like 6, but more hairy and only very shortly awned. Common about Tatkon. Not of much use as a fodder grass. (Burm. mwe-zok)

(*c*) Spikelets arranged in irregular 1—2 series on very slender branches.

9. **P. prostratum.**—Distinguishable by the long hairs (cilia) on the pedicels of its spikelets. Important in the dry zone. Common on the Mandalay station where it supplies good herbage during the mid and late rains.

10. **P. javanicum.**—Distinguished by its broad leaves, creeping (decumbent) habit and rather large spikelets. The latter are slightly hairly. common in the dry zone where it occurs along with P. Flavidum. It is a useful pasture grass. Plate V.

11. **P. distachyum.**— Like the above but there are no hairs on the spikelets (glabrous). Plate VI.

(*d*) Spikelets arranged in spikes the rat-tail group of panicum.)

12. **P. myurus.**—Found in marshes all over Burma.

13. **P. interruptum.**—Like the above but the spikelets arranged irregularly on the spike like panicle.

14. **P. indicum.**—Like 12 but the spike much shorter and usually stouter.

15. **P. myosuroides.** Like 12 but the spike much finer.

These four grasses are found in fields all over Burma. They are all useful nd are cut and fed to cattle.

(*e*) Spikelets arranged simply on an open panicle.

16. **P. miliaceum.**

17. **P. repens.**

18. **P. maximum.**

The first two are found in marshy places. P. repens is esteemed in the Shan tates but I do not think it is much valued in Burma proper. It is a common rass of paddy bunds in both Lower and Upper Burma.

P. maximum is cultivated Guinea grass. It grows well on the high sandy lateritic " kons " of Lower Burma and can withstand the drought of the hot onths without irrigation. It does not, however, unless irrigated, yield cuttings that season of the year. It also grows well under irrigation on the Mandalay m. It may yield up to 30 tons of green fodder per acre in a single season. is always propagated by root division but can also be grown from seed.

THYSANOLAENA.

19. **T. Agrostis.**—A very large grass—up to 12 feet in height—and bearing panicles carrying innumerable small spikelets. From these panicles the common sweepers' brooms are made; hence its name—thabyetsi-bin. Common in Lower Burma.

CHAMAERAPHIS.

These are aquatic grasses. They are easily distinguished by the branches of the panicle being produced beyond the terminal spikelets and ending in an awn-like bristle.

20. **C. Spinescens** is common in borrow pits in Lower Burma. It has no particular value.

AXONOPUS.

The genus is distinguished by the cleft palea of glume III.

21. **A. cimicinus** is very common in Lower Burma. It is not of much agricultural importance.

22. **A. semi-alatus** is not so common. It is usually a sign of wet undrained land.

OPLISMENUS.

This genus is distinguished by its weak habit and by its thin papery leaves. It is fond of growing in the shade of large trees.

23. **O. compositus.**

24. **O. Burmannii** are found in Burma. They are of little agricultural importance.

ARUNDINELLA.

Like Isachne this genus is also an exception to the rule that in Panicaceae the spikelet are deciduous on their pedicels.

25. **A. birmanica** is found on paddy bunds at Hmawbi and elsewhere in Lower Burma. It has a linear oblong panicle on which the spikelets are densely crowded. The herbage is dry and coarse and not of much value although sometimes cut with other grasses.

Setaria.

The word " seta " means a bristle and these grasses are distinguishable by having the spikelets arranged densely on a spike each spikelet being surrounded by a ring of bristles.

26. **S. glauca** is a common roadside grass. It is of considerable value in the dry zone districts and is cut and fed to cattle.

27. **S. verticillata** is a common dry zone grass growing (often to a height of 6 feet or more) in the shade of trees and hedges. It is grazed and also cut and fed to cattle.

28. **S. italica** is cultivated for its grain in Myingyan and other dry zone districts and is known as "sat."

Pennisetum.

These grasses differ from the Setarias in that instead of each spikelet, as in Setaria, being surrounded by a ring of bristles, in pennisetum the ring of bristles surrounds a group of 1—3 spikelets.

29. **P. Typhoideum** is the cultivated bulrush millet or Bajra of India. A little is cultivated in Sagaing and other dry zone districts.

Oryza.

This genus comprises the wild and cultived rices. They are easily distinguished by the two small glumes at the base of the larger. Two wild rices are found in Burma as follows:

30. **O. sativa.**—Creeping or floating in borrow-pits and pools of water. The ligule as in cultivated rice is long and divided in two parts down the middle. Reddish coloured awns are usually present. This is the form from which all the cultivated rices have probably been derived and to which they are nearly related.

31. **O. latifolia.**—A tail grass growing in swamps and marshes. The grain is rounder than in 30, the leaves broader, and the ligule is very short. The above two are often cut and fed to cattle.

Leersia.

This is very like Oryza in appearance but it lacks the two small empty glumes.

32. **L. hexandra** is an aquatic grass common in marches and rice fields. It is of some use as a fodder.

Tragus.

A small grass (Burm. wa-yon-myet) found only in the dry zone. The spikelets are crowded on the spike in pairs, face to face, so that each pair appears to be a single spikelet only.

33. **T. racemosus** is common all over the dry zone where it occurs associated with P. flavidum, P. javanicum and other grasses. Its herbage is rather harsh and dry but it is grazed by sheep and goats and is of some value. Plate VII.

Perotis.

A grass with long awns and short broad leaves. The awns are usually purplish in colour.

34. **P. latifolia** is common on high *yas* in the dry zone. It is of no value.

Coix.

35. **C. Lachryma-Jobi** or Job's Tears is common along the railway line n Lower Burma and also in the northern wet zone. There are several cultivated forms in the Chin and other hill tracts. The white seeds used in ornamenting Shan bags are sometimes those of this grass. It bears 3 male spikelets situated above the ovoid female spikelet. It often reaches a height of 5 or 6 feet and can be cut and fed to cattle.

Polytoca.

These are tall grasses bearing spikes of male and female flowers mixed, the lower being female or bisexual and the upper male only. The female spikelets are imbricate.

36. **P. Wallichiana** occurs in mid-Burma and the Southern Shan States and bears leaves two or three feet long. These can be fed to cattle, but the sharp hairs in the sheathing leaves are rather a disadvantage.

The above two genera are closely related to the maize (Zea Mays) plant which occurs in Burma in a cultivated state only.

Dimeria.

Slender tufted grasses forming a foggy herbage on the Kazins of paddy fields in Lower Burma.

37. **D. pusilla D. Kurzii** are found. They have little or no agricultural value.

Imperata.

38. **I. arundinacea** is the common "*thetke*" or thatching grass of Burma. It is found in moist soils all over the province and is easily told by its long leaves and white feathery panicle. Buffaloes graze this grass in its younger stages.

The name "*thetke*" used for thatching grass often covers several other grasses than Imperata, *e.g.* Andropogon Squarrosus and Anthistiria gigantea are also used for this purpose.

Pollinia.

39. **P. birmanica** and several other pollinias are found in the mid-zone "*in*" forest regions. They have silky sub-digitate spikes by which they can easily be told. They appear to have no particular agricultural value.

Saccharum.

Two species of Saccharum constitute with some other genera, the well known "kaing" grass. They are easily distinguished by their giant habit and by their beautiful silvery silky panicles which are so conspicuous an object along the railway borrow pits and along rivers in the cold weather.

S. spontaneum and **S. arundinaceum** are the common species. These are best distinguished by the markings on their nodes as follows :—

40. **S. spontaneum** has usually two or more rows of root eyes at the node.

41. **S. arundinaceum** has never more than one row of root eyes and has hairy leaf sheaths. It is a much taller grass than S. spontaneum.

Both of these grasses are grazed by buffaloes and occasionally by cattle in their young state.

Ischaemum.

This is a most important genus comprising some of the best Lower Burma grasses. The spikelets are usually two flowered and are arranged in digitate fragile spikes. The spikelets also occur in pairs—one sessile and the other pedicelled. The first glume has its margins inflexed, that is, bent round, and is often divided into two tips or cusps. The fourth glume is usually awned.

The following are the principal species in Burma :—

42. **I. aristatum.**—Grows on paddy bunds in Lower Burma. The first glume has 2 to 4 low transverse ridges. An excellent fodder grass. Occasionally found as an immigrant on paddy bunds in canal tracts in the dry zone and is also common in the north wet zone. Plate VIII.

43. **I. ciliare.**—The first glume ends in two terminal wings (auriculate). A good fodder grass growing on paddy bunds in Lower Burma. Plate IX.

44. **I. hirtum.**—Very like 43 but the spikes are more slender and the first glume, instead of ending in two wings, ends in two pointed tips or cusps. Grows on paddy bunds and higher land in Lower Burma and is a good fodder grass. Plate X.

45. **I. rugosum.**—The spikes are pale yellow in colour and the first glume of the spikelets is crossed by transverse ridges. This plant grows in paddy fields and wet places in Lower Burma but is not a good fodder grass.

46. **I. laxum.**—Known by its solitary spikes and the reddish coloration of its foliage. It grows in wet places and is sometimes a weed in Lower Burma paddy fields where it flowers in May and June. It does not appear to be much esteemed in Burma as a fodder grass.

Eremochloa.

These grasses can readily be told by the pectinate (or comb shaped) edges of the first glume.

The spikelets are flat and arranged simply on one side of a narrow compressed spike. They are not of importance as fodder grasses and are usually

found on wet badly drained grazing grounds. Their brown coloured glumes at the time of flowering impart a reddish tinge to the whole grazing ground. The two commonest are :—

47. **E. bimaclulata** and

48. **E. leersioides.**

Apocopis.

49. **A. Wightii** is found growing in the "*In*" jungle in mid-Burma and also in the Northern wet zone about Hopin. The spikelets are in pairs and two-flowered, the lower flower bisexual and the upper female. The characteristic mark of this genus is the broad, cuneiform (or wedge shaped) first glume. The grass is of little importance for fodder purposes.

Rottboellia.

These are tall grasses often growing to 10 feet in height. The rachis of the spike is fragile. The spikelets are in pairs, one sessile and one pedicelled. The latter often has its pedicel adhering to the joint of the rachis.

50. **R. exaltata** occurs in Lower and mid-Burma. It can be cut and fed to cattle and often grows to a height of 6 to 8 feet or more.

Ratzeburgia.

51. **R. pulcherrima** is a pretty little grass forming one of the constituents in the common dry zone mixture. The spikelets are tinged with reddish purple and are arranged in opposite pairs on a slender elastic spike. The grass is quite unlike any other. It is of some importance to sheep and goats in the dry zone.

Andropogon.

This is one of the largest and most important of all the genera and embraces many important fodder grasses. The Andropogons can be distinguished by the following characters ; (1) narrow leaves ; (2) jointed, usually fragile rachis ; (3) spikes often but not always emerging from a spathaceous leaf sheath ; (4) spikelets in pairs the lower sessile and female or bisexual the upper pedicelled, male or neuter.

The following are the principal species of importance :—

(*a*) Those having single spikes in the axil of spathiform leaf-sheaths.

52. **A. foveolatus.**—Common in the dry zone and a useful fodder grass (Burm. padawpyu).

(*b*) Those having spikes in pairs or digitate in the axil of a spathiform leafsheath.

53. **A. apricus.**—Common in the "*In*" jungle of the mid-zone. A tall grass 3—5 feet high.

54. **A. pumilis.**—A dry zone grass but not very abundant. It has a semi-creeping habit and is only 12′ — 18″ high.

(*c*) spikes in fascicles.

55. **A. pertusus.**—Known by its silky spikes and by glume I of the pedicelled spikelet having 1 or 2 pits or pin holes. Common in the dry zone and is of some use although some cultivators state that cattle dislike its bad smell and bitter taste. (Burm. padaw-pyu). Plate XI.

(*d*) Those having an open panicle---the jowar or pyaung group.

56. **A. sorghum.**—This is cultivated jowar or pyaung, the most important cultivated fodder plant in the dry zone of Burma.

57. **A. serratus.**—Can be told by its reddish brown coloured hairy spikelets. A tall handsome grass much esteemed as a fodder plant in the dry zone (Burm. Naya.) Plate XII.

58. **A. squarrosus.**—A tall coarse grass as high as 5 feet or higher always growing in wet ill-drained land of which latter it is a sign. Usually associated with kaing grass. Its foliage in a young state is grazed by buffaloes and cattle.

59. **A. aciculatus.**—Lower Burma spear grass. Easily known by its spears and by its panicle of whorled spikes. Important as a fodder. It grows on paddy bunds, along roadsides and on the high laterite "kons" of Lower Burma. It is one of the earliest of Lower Burma grasses and affords the first bite of green stuff to cattle after the long hot weather. It is common also in the north wet zone. Plate XIII.

(*e*) Those in which the lowest one or more of the sessile spikelets differ from all those above it in sex or form.

60. **A. caricosus.**—Common in the dry zone where it is perhaps the most important pasture grass. It grows on paddy bunds and on the richer low lying lands. (Burm. padaw-ni) Plate XIV.

61. **A. contortus.**—Upper Burma spear grass. Common in the "In" jungles of mid-Burma. Easily told by the long awns and the curved callus of its upper spikelets. Grazed by cattle in the early stages of its growth. It forms the main bulk of the herbage over large tracts (Burm. myauk-mya). Plate XV.

62. **A. Schanaenthus.**—A tall grass common in Upper Burma and known by the peculiar smell of its leaves, when the latter are crushed and by their hot chilly-like taste. It is Rusa or Geranium Oil grass and is sometimes cultivated in India for the production of this valuable oil. Oil does not seem to be got from it in Burma. It is given to cattle only when in the dry state when they are said to like it. Owing to its hot taste it cannot be fed green (Burm. *myet-nan*). Plate XVI.

63. **A. Nardus.**—This is the well known citronella grass grown extensively in gardens for use as a flavouring material and cultivated at Moulmein and elsewhere for the extraction of Citronella oil. There are many varieties of this grass.

63. (*a*) **A. citratus, Stapf.** is the well known Lemon grass grown in gardens all over Burma for use as a flavouring material in cookery.

ANTHISTIRIA.

64. **A. ciliata** occurs in the dry zone and in mid-Burma. It is often cut and brought in for sale to the bazaar. It can be told by the four lowest pairs of spikelets being male or neuter and arranged in a whorl. Above this the fertile awned spikelets occur in pairs as in Andropogon.

In India this grass covers extensive areas of jungle and is considered one of the best for drying and baling into hay. Plate XVII.

64. (*a*) **A. gigantea** is found, growing up to 16 feet in height in borrow-pits in the north wet zone.

B. Poaceae.

SPOROBOLUS.

This genus has small or minute spikelets usually one flowered and awnless. There are three glumes.

65. **S. coromandelianus** forms one of the constituents of the dry zone herbage and is a good fodder grass. It can be easily told by its pyramidal panicle. Plate XVIII.

66. **S. tremulus** is found growing in Lower Burma paddy fields and is usually in flower towards the end of the hot weather. It is sometimes mistaken for " doob " grass although its panicle is quite different. It has some slight value.

Cynodon.

This and the three following genera belong to a well defined group in which the spikelets are secund on the unjointed rachis of a racemed panicle.

67. **C. dactylon.**—The well known " doob " grass. Found all over the country by road sides, in cultivated fields and in pastures. It is, however, pre-eminently a grass of " non " or alluvial soil. It is considered to be the best of all grasses for conditioning ponies. It is also the best grass for lawns and golf greens. On these it can be propagated by cutting up the roots and making a paste of soil and cow dung with which the roots are mixed. The paste is then spread on the surface of the lawn and irrigation applied till the roots strike. If a lawn has to be made on stiff clay such as Mandalay it is best to apply first a heavy dressing of canal or river silt to which burnt paddy husk has been added and then plant the " doob " as described above. Manuring with Sulphate of Ammonia greatly stimulates the growth of " doob " grass. In the Lower Burma wet zone lawns can be made by simply cutting up the stems and scattering them on the surface of the ground along with a little cattle manure, or in Rangoon, municipal mould. Constant weeding during the first year and rolling at the end of the rains is required to establish the lawn. Burmese name Mye-sa.

This grass is said to have established itself on sandy soils on the East Coast of England. Plate XIX.

Chloris.

68. **C. barbata**—Is a common and pretty roadside grass and also fairly common in pasture in the dry zone. It is not of much use as a fodder. The well known fodder " Rhodes grass " belongs to this genus.

Eleusine.

These grasses are known to Burmans as " le-gwa " or " sin-ngo-myet " (elephant's tears) and are much esteemed. They are essentially grasses of rich cultivated soils where they occur as weeds or are found growing on rich manured soils by roadsides. They are easily told by their digitate spikes and robust growth. They are found all over the province wherever soil and water conditions are suitable for their growth. The principal are :

69. **E. indica** (*sin-ngo-myet*). Plate XX.

70. **E. aegyptica** (*le-gwa*).

A cultivated form E. coracana in India is known as "nachari" "marwa" or "ragi" and is the real "small" millet. Plate XXI.

71. **E. verticillata.**—This is a form closely resembling 69 except that the branches of the panicle instead of being digitate are arranged in whorls. It is found in cultivated fields in the dry zone.

Leptochloa.

These are moisture loving grasses which can be told by their slender inflorescences of whorled spikes bearing very minute spikelets arranged in an alternate or zig-zag manner on the rachis. The two most important are :—

72. **L. filiformis** has 2—3 flowered spikelets.

73. **L. chinensis** has 4 to 6 flowered spikelets.

They are often cut and used as fodder. L. chinensis is the most important and bundles of it are often cut from paddy fields in the dry zone where it is considered an excellent fodder, the herbage being sweet and succulent.

Arundo.

74. **A. Donax.**—This is the reed grass growing among kaing and distinguishable from the true "kaing" or Saccharum by its darker coloured, not silky, inflorescence and its hollow stem. It is grazed by buffaloes and its stems are used as the framework for the "thetke baws" used in roofing Burmese houses.

Eragrostis.

This is a large genus the members of which are easily known by their many-flowered spikelets resembling the "Fescues" of Europe.

75. **E. tenella** is one of the commonest dry zone grasses and has several varieties. It is a useful fodder grass. The variety "viscosa" has a sticky inflorescence and is not grazed. (Burmese myet-mwa). Plate XXII.

76. **E. amabilis** is a pretty and common wayside grass, very common near Rangoon and in the north-west zone. Not of much use as a fodder. Plate XXIII.

77. **E. major** occurs as a weed of cultivated land in the mid and dry zone and is one of the handsomest grasses in the province with large silvery spikelets nearly half an inch long. It is of some use as fodder.

78. **E. cynosuroides.**—dogs' tail grass. Is found in the dry zone mainly as a weed of cultivated fields and also occasionally on higher ground in Lower Burma. It is cut and fed to cattle.

79. **E. interrupta** is a tall grass growing in association with the Saccharums, Arundo and Andropogon squarrosus in wet places. It is grazed by buffaloes and cattle in its young state. Common all over wherever the water supply is sufficient and often a bad weed.

ARISTIDA.

80. **A. Adscenscionis** is a common grass on the dry upland "yas" of Upper Burma. It is easily told by its contracted panicle of thin spikelets with long awns each awn having three branches. It is of little importance as a fodder although sometimes cut along with other grasses.

ELYTROPHORUS.

81. **E. articulatus** is a conspicuous grass in Lower Burma rice fields where it is in flower at the time of the rice harvest. It grows in the fields and is distinguished by the light green colour of the foliage and its dense spikes of flowers. The latter form globose sessile clusters along the spike. Its herbage is scanty and coarse and it is not of much importance as a fodder.

III.—DISTRIBUTION OF GRASSES IN BURMA.

From a climatic point of view what is known as the Province of Burma may be divided into five main regions as follows :—

(1) Lower Burma comprising the delta of the Irrawaddy and the Tenasserim Division, and extending north to about latitude 20° N. This is a region characterised by a heavy monsoon varying from 80 to 200 inches. The rains occur between the months of May and October and during the rest of the year with the exception of occasional showers in March and April no rain falls at all.

(2) An intermediate tract with a rainfall varying between 35 and 80 inches. This includes the Toungoo, Southern Yamèthin, Prome, Northern

Henzada and Thayetmyo districts. The typical botanical formation is the well known " In " or deciduous forest of which the most characteristic tree is the " In " (Dipterocarpus tuberculatus). The country consists in parts of low-lying lands with the mountain chain known as the Pegu Yomas traversing them from North to South. The Yomas are of Tertiary formation and they have been formed from the weathering " in situ " of Pliocene and Miocene beds and more especially the former.

(3) The " dry zone " of Burma. This is really an elliptical patch comprising the districts of Sagaing, Lower Chindwin, Shwebo, Meiktila, Myingyan, Kyauksè, Pakôkku, Minbu and parts of Yamèthin and Thayetmyo. The rainfall varies from 25 to 35 inches and the prevailing botanical formation is Acacia scrub. On the whole this tract consists of broken undulating country narrow valleys alternating with low hills. In parts, however, such as at Mandalay, Mônywa and Minbu the plains are of extensive area. The soils vary from stiff clay in the hollows to light sands and sandy gravels on the higher land. They appear to have been all formed " in situ " from beds either of Miocene or Pliocene.

(4) A northern wet zone comprising the Myitkyina, Katha, Bhamo and Ruby Mines districts. The rainfall varies from 60 to 100 inches. This tract resembles the mid-zone above described.

(5) The Shan States. This great tract of country lies between Burma and China and is administered by native chiefs or *Sawbwas*, under British protection. It is a plateau with an average elevation of between 3,000 and 4,000 feet but cut across generally in a North and South direction by long deep valleys the drainage being into the Salween and Irrawaddy rivers. The rainfall on the plateau is only 35″ at Heho and 45″ to 5o″ in the Yawnghwe valley.

Taking the various tracts in order we find the distribution of grasses to be as follows :—

1. The Lower Burma Wet Tract.

Here the country is a grea tlevel rice plain with the two great mountain ranges of the Arakan Yomas on the west and the Shan mountains on the east. Here and there smaller heights or " kons " occur which represent the remains of the Tertiary formation. The level plains consist of old alluvium, laid down in the sea by the Irrawaddy river or its precursor and raised up again to form the land of to-day. The soil is a yellowish coloured loam the proportion of sand varying considerably.

On the higher lands that occur here and there and on which the villages are usually built the soil is generally a light sand or lateritic gravel but

occasionally in places beds of yellow clay appear. The higher lands consist of Tertiary sandstones with an apron of laterite abutting on the alluvium at their foot.

The grasses occurring in this region may be grouped as follows :—

(*a*) growing in rice fields—

Sporobolus tremulus.
Cynodon dactylon.
Elytrophorus articulatus.
Ischaemum laxum.
Panicum Crus-galli.
Leptochloa chinensis.

(*b*) Growing on the bunds of rice fields—

Ischaenum aristatum.
Ischaenum hirtum.
Ischaenum ciliare.
Arundinella birmanica.
Andropogon intermedius.
Andropogon acicularis.
Isachne miliacea.
Saccharum spontaneum (occasionally).
Imperata arundinacea (occasionally).
Panicum repens.
Paspalum scrobiculatum.
Paspalum sanguinale.
Eragostis stenophylla.
Dimeria Kurzii.

The dominant feature of paddy bund vegetation in Lower Burma is the presence of the three Ischaemums which come first in the above list. They are largely used for feeding to cattle and are considered the best grasses for that purpose.

(*c*) In marshes, jheels and borrow-pits—

Panicum indicum.
Panicum interruptum.
Panicum Myurus.
Panicum myosuroides.
Panicum Crus-galli.
Panicum caesium.
Leersia hexandra.
Chamœraphis spinescens.

Oryza sativa.
Oryza latifolia.
Coix Lachryma-Jobi.

(*d*) On the heights of land known as " kons —

Andropogon aciculatus
Cynodon dactylon
Panicum javanicum
Ischaemum hirtum
Ischaemum ciliare
Panicum colonum
Eragrostis cynosuroides (rare)
Eragrostis gangetica
Eragrostis amabilis
Eleusine indica
Eleusine ægyptica
} On richer garden soils only.

Saccharum spontaneum
Saccharum arundinaceum
Andropogon squarrosus
Arundo Donax
} In wet hollows of the uplands.

Thysanolæna Agrostis
Centotheca lappacea
} Giant grasses comparatively rare.

The most characteristic grass of these uplands or " kons " is Andropogon aciculatus. It is an important pasture grass. Besides the above grasses and other plants a very characteristic feature of these Lower Burma uplands is the growth of the sensitive plant—Mimosa pudica—which is here an immigrant. In Burma its range is almost exactly coterminous with that of Andropogon aciculatus.

(*e*) In the Rains forest. In dense forest grasses are comparatively rare but there are two very characteristic of the shadier parts. These are :

Panicum plicatum and Oplismenus compositus.—In openings of the forest Imperata, Saccharum, Arundo and Andropogon squarrosus are common.

2. The Mid Zone or In forest region.

This region extends both east and west of the Pegu Yomas and includes part of Toungoo and Yamèthin districts on the east and part of Thayetmyo and Prome on the west. There is also a northern intermediate zone of which Northern Shwebo is the most important part. The hills (Yomas) are covered

with deciduous or " In " jungle and the lower parts are either flat paddy fields or rolling " yas " that is upland fields or farms. So far as the graminaceous flora is concerned two well marked regions occur as follows :

(*a*) Paddy bunds and fields in the lower parts. An examination of these shows us at once that a fairly complete change from the grasses of the Lower Burma wet tract has taken place. The Ischaemums that were the principal characteristic of the Lower Burma paddy bunds have vanished and their place is taken by the following group :—

Andropogon caricosus
Andropogon pertusus
Andropogon foveolatus
Andropogon contortus
} On paddy bunds.

Anthistiria ciliata (common in Shwebo)
Axonopus cimicinus
Eragrostis cynosuroides (rare)
Sporobolus diander

Ischaemum aristatum is occasionally found but is comparatively rare.

(*b*) On higher land and on the foot-hills of the Yomas.

Andropogon contortus
Andropogon apricus
Andropogon Schœnanthus
Andropogon serratus
Eleusine indica
Eleusine ægyptica
Eleusine major
Eleusine cynosuroides
} On richer soils and cultivated fields.

Rottboellia exaltata
Anthistiria ciliata
Polytoca Wallichiana
Pollinia spp.
Aristida Adscenscionis

The most characteristic grass of the foot-hills is A. contortus which is very abundant and largely grazed by cattle. A. schoenanthus appears to favour the hardest soils of the hill-tops. Anthistiria is not so common as in parts of India. It favours the moister parts.

The most striking change in passing to this tract from the Lower Burma regions is undoubtedly the disappearance of the Ischaemums and their replacement by the series of Andropogons given above.

Jheels, borrow pits and swamps carry the same grasses as in Lower Burma and the series of grasses found there in rich garden land (Eleusine etc.) are found on similar soil in this tract.

3. The Dry Zone Tract.

Here the prevailing tree vegetation is Acacia scrub—*A. arabica*, *A. catechu*, *A. leucophlea*, *A. Concinna* being abundant. On the lower lands—paddy field and bunds, etc., there is no change in passing from the mid zone tract and the series of Andropogons still persists. Similarly wherever jheels, swamps, etc., occur the same series of aquatic and semi-aquatics as occurred in Lower Burma is also found here.

On the higher land in this tract, however, another marked change takes place. The country is a rolling one the prevailing geological formation being the Pliocene. In the valleys between the small hills or uplands rice is grown wherever water can be found and on the rice fields as has been said we meet again the same series of grasses as in the mid zone.

The uplands are variable. Sometimes they are fairly flat and possess good soil in which sesamum, cotton, millet and groundnut are grown. In these cultivated fields we find again the series of *Eleusine indica*, *Panicum colonum* *Eragostis cynosuroides*, etc., which occur in Lower Burma. In addition *Perotis latifolia* is abundant. Where however the land is under permanent pasture as in fuel and grazing reserves a quite distinct vegetation characteristic of this region is found. It forms a close turf and consists of the following :—

Panicum flavidum
Panicum javanicum
Tragus racemosus
Sporobolus coromandelianus
Cynodon dactylon
Eragostis tenella
Ratzeburghia pulcherrima
Panicum prostratum

The above grasses are found in association all over the dry zone. In addition the following are characteristic :—

Setaria glauca (by road sides).
Setaria verticillata (in shade of hedges).
Aristida Adscensionis (on the highest and poorest soil).

4. The Northern Wet Zone.

In this the conditions approximate more to those of the Southern wet area. The Andropogons of the dry zone are replaced once again by the Lower Burma grasses, *viz.*, *A. acicularis* and *Ischœmum aristatum*. A very characteristic grass of this region found growing in borrow pits is *Anthistiria gigantea*. This often reaches a height of 10 feet or more. It is accompanied by the usual kaing grass or Saccharum.

The following were found in flower in November 1921 on the bunds of paddy fields at Hopin in the Myitkyina District :—

Paspalum scrobiculatum
Eragrostis gangetica
Eragostis amabilis
Setaria glauca } (common)
Panicum myosuroides
Panicum colonum
Ischœmum aristatum
Eleusine indica (scarce)
Cynodon dactylon (common)
Leersia hexandra (scarce).

5. The Southern Shan States.

This is a vast plateau with successive ranges of mountains crossing it in a more or less north and south direction with intervening valleys. The rainfall is intermediate between the dry and wet zones of Burma. At the Yawnghwe Agricultural Station it is about 35 inches. The average elevation of the plateau is about 3,000 feet.

An examination of the herbage at Heho, Yawnghwe and Taunggyi in October 1922 revealed no grasses that had not previously been met with on the plains. In dry or "taungya" paddy fields *Paspalum sanguinale* was dominant. *Imperata arundinacea* or "thetke" grass is also very common in the yas about Heho.

On the kazins of paddy fields *Panicum repens* (myet-ka) was dominant and was said to be a good grass for cattle. Next to it in importance came *Ischœmum aristatum* (the principal kazin grass of Lower Burma). Lower Burma spear grass—*Andropogon acicularis*—was also found.

Isachne miliacea (*myet-wine*) was found being cut from paddy fields and Kazins and was said to be the best grass for ponies.

On the whole the Southern Shan States grasses may be said to be a mixture of the Lower and Upper Burma groups with the former more abundant. This is shown by the fact that the two well-known Lower Burma leguminous plants—*Mimosa pudica* (sensitive plant) and *Smithia sensitiva* —are found here but not in the dry zone of Burma.

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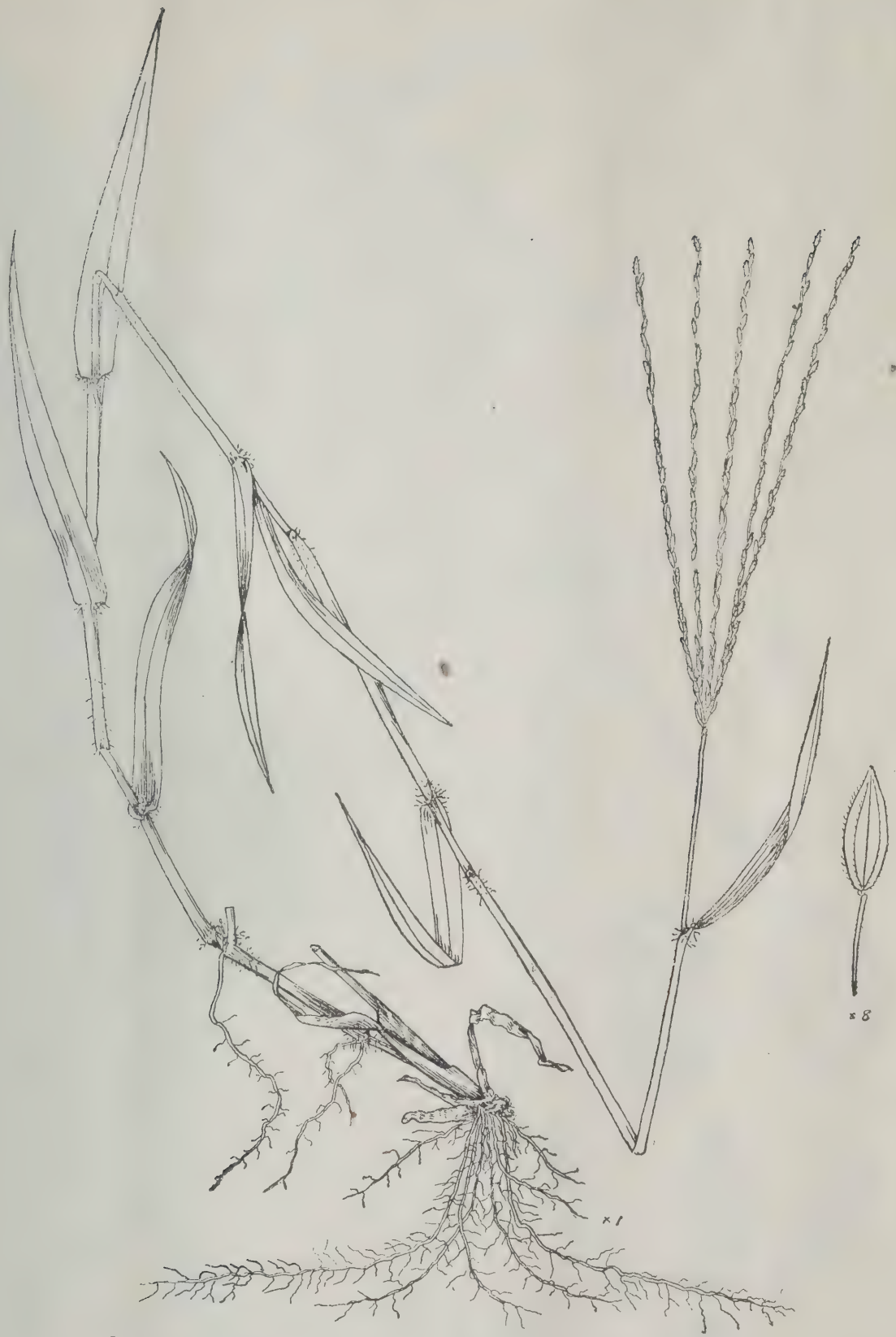

Plate 1. Paspalum sanguinale. (Lêt-thè-gwa)

Plate II. *Panicum flavidum*
(Sin-ngo-myêt)

Plate IIIN. Panicum Crus-galli (Myêt-thi, Myêt-si)

Plate IV. Panicum colonum. (Wumbè-sa)

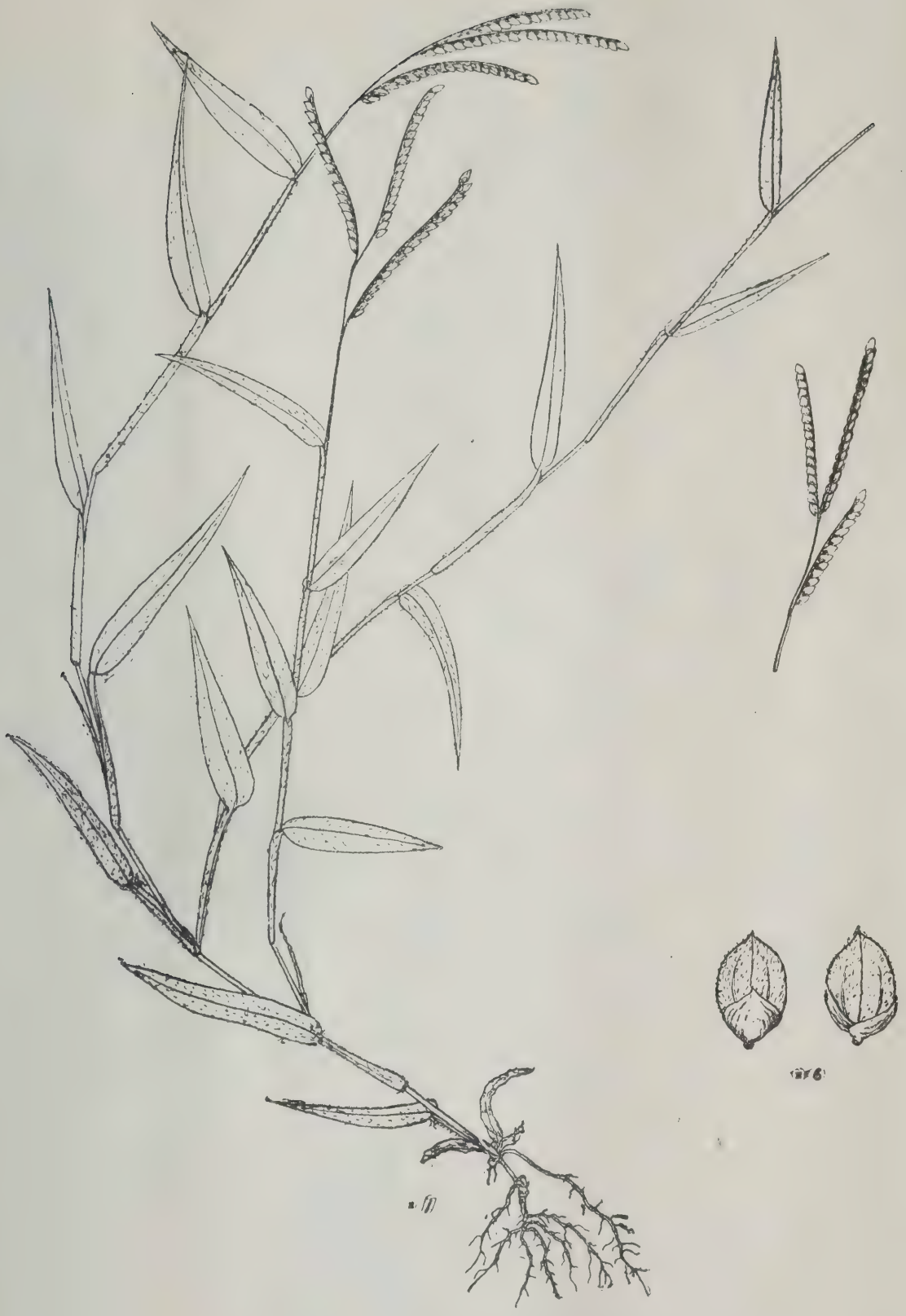

Plate V. Panicum javanicum

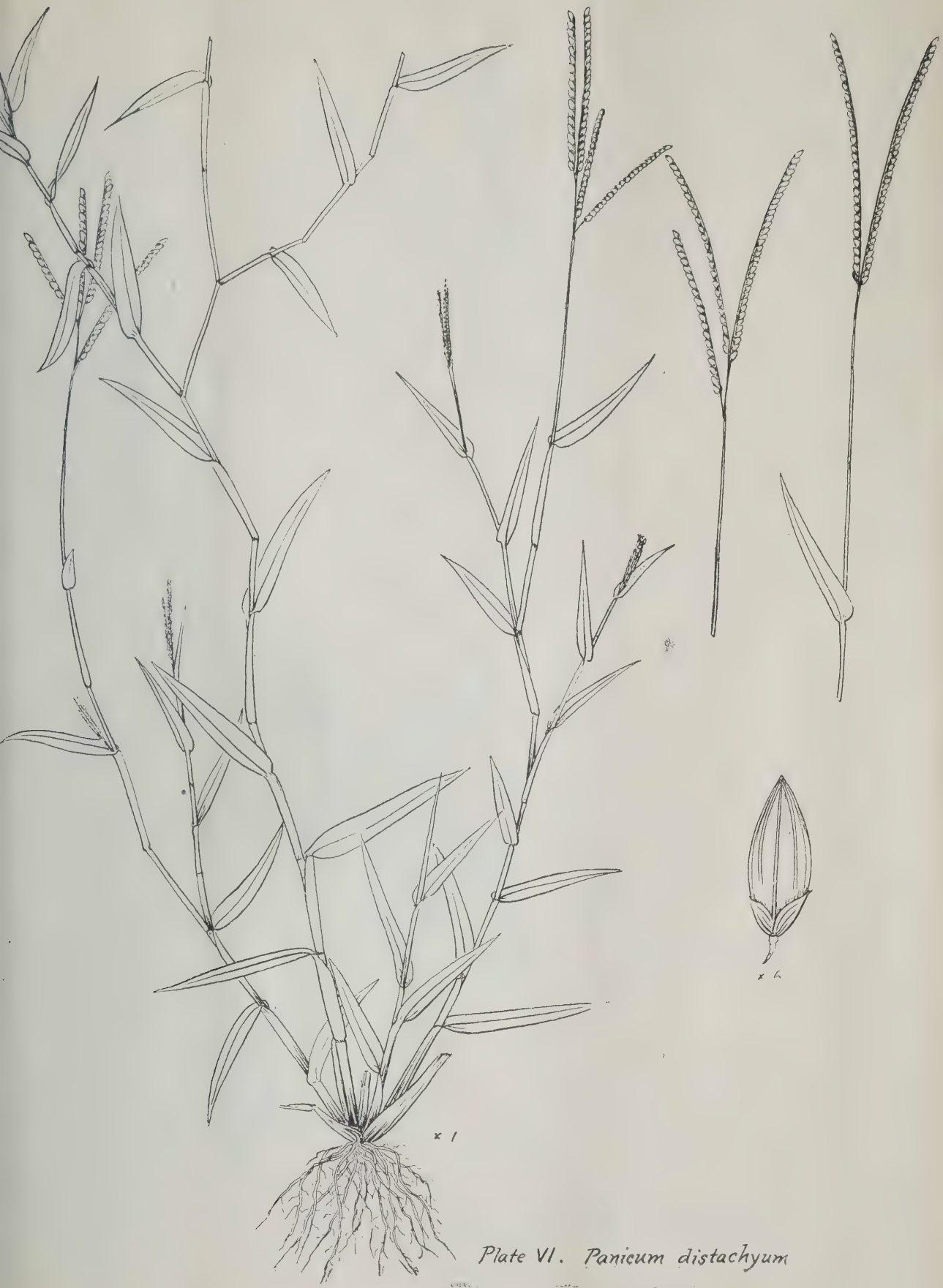

Plate VI. Panicum distachyum

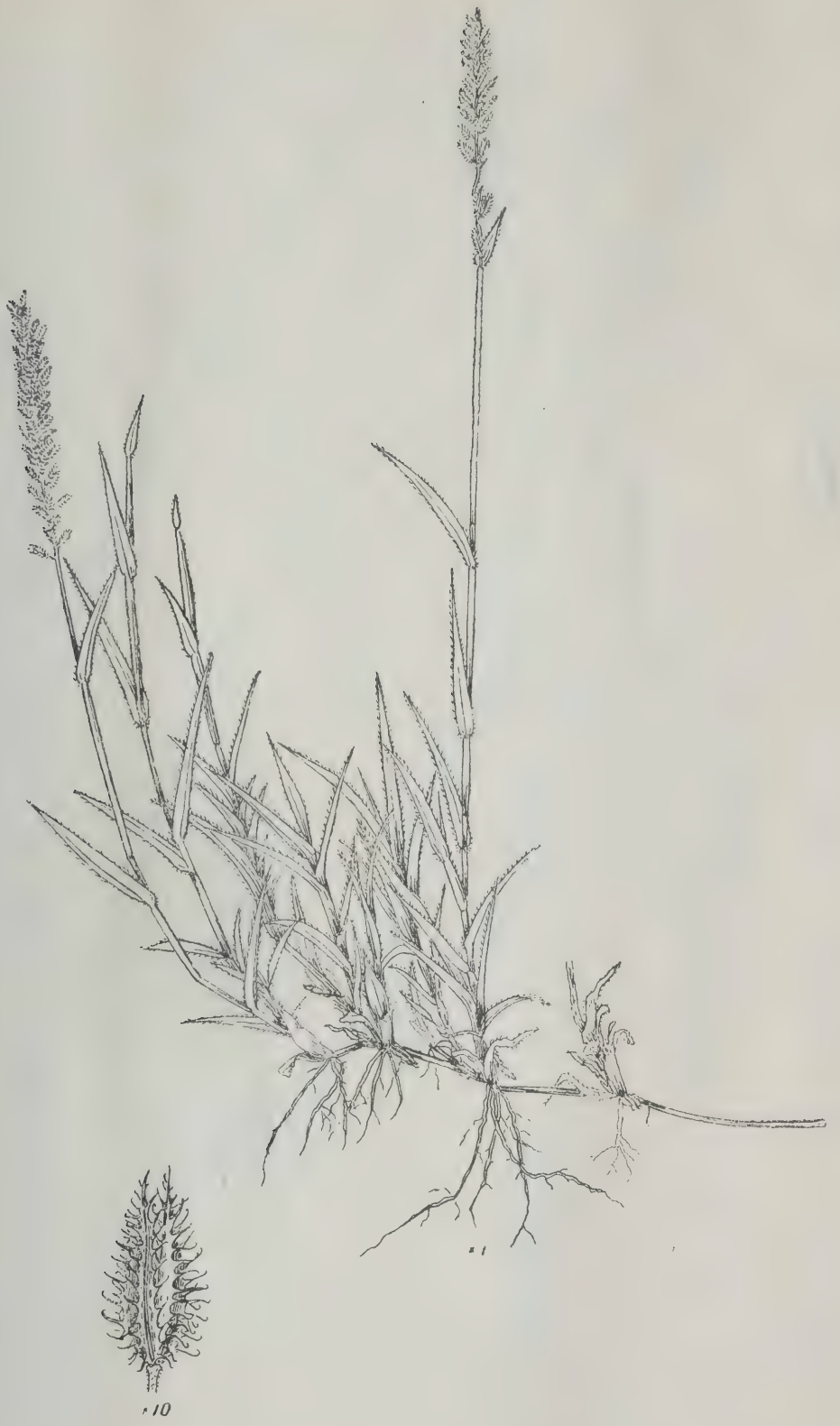

Plate VII. Tragus racemosus (Yôn-galè)

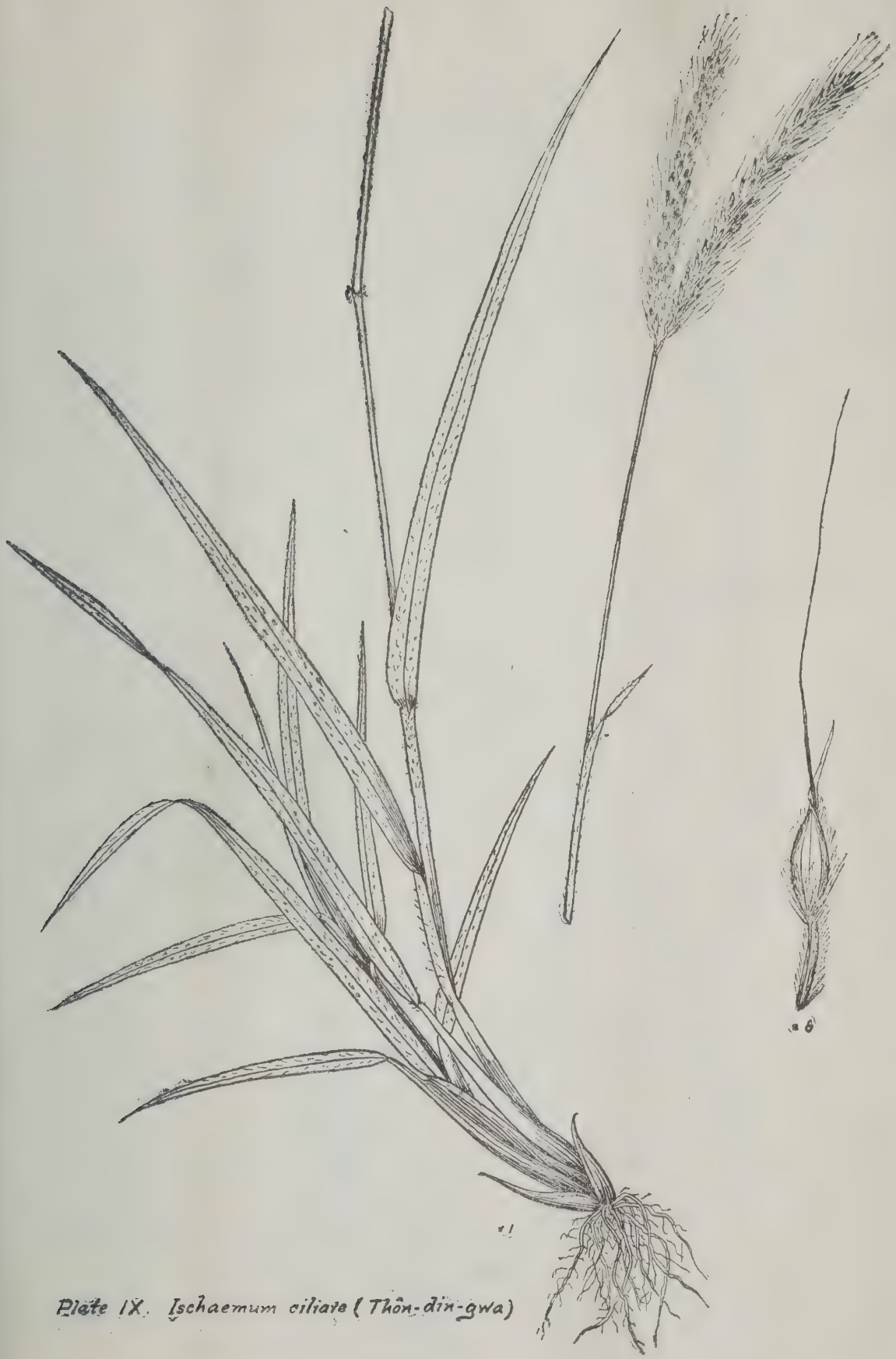

Plate IX. Ischaemum ciliare (Thôn-din-gwa)

Plate X. Ischaemum hirtum. (Padaw)

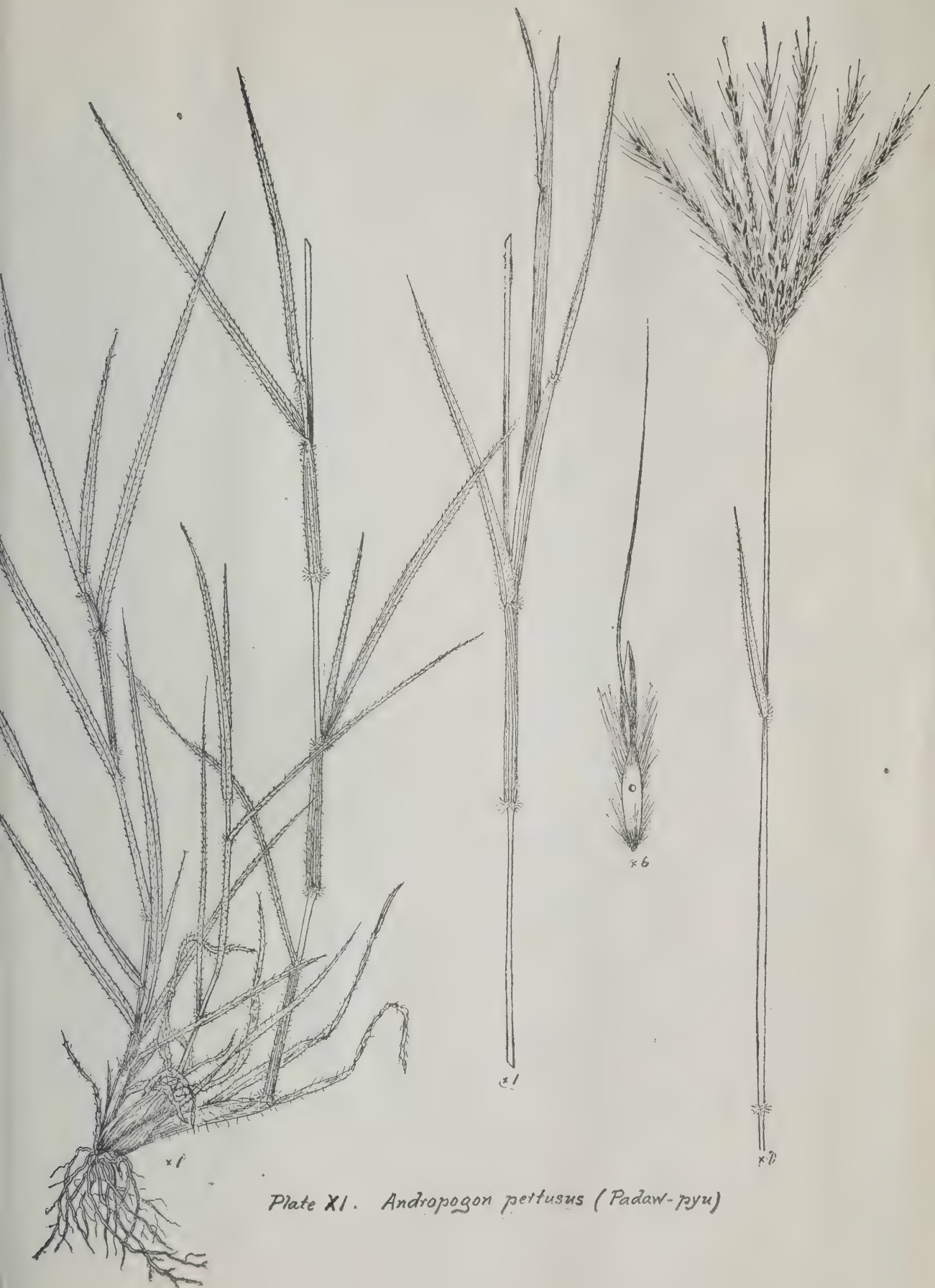

Plate XI. Andropogon pertusus (Padaw-pyu)

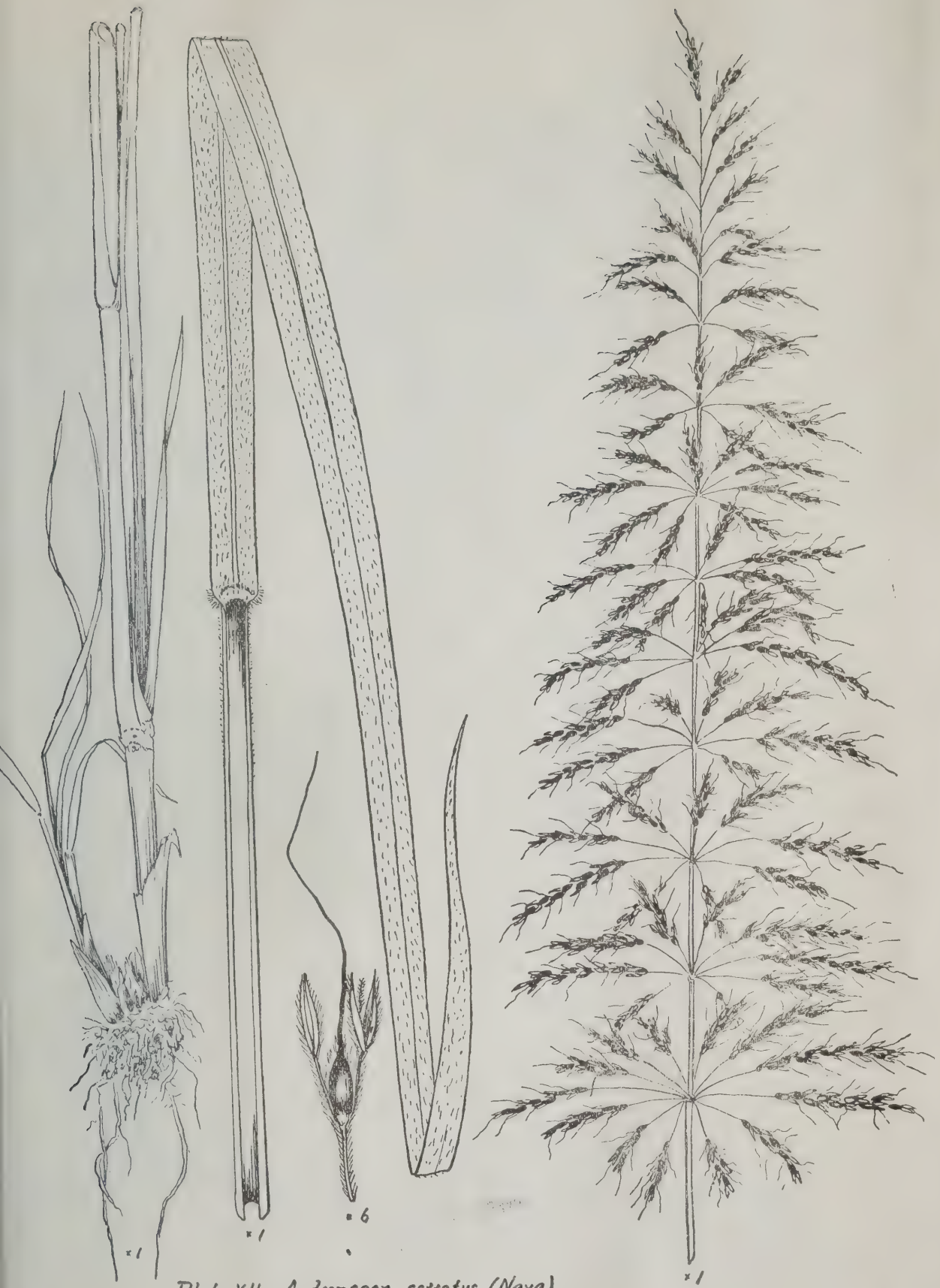

Plate XII. Andropogon serratus (Naya)

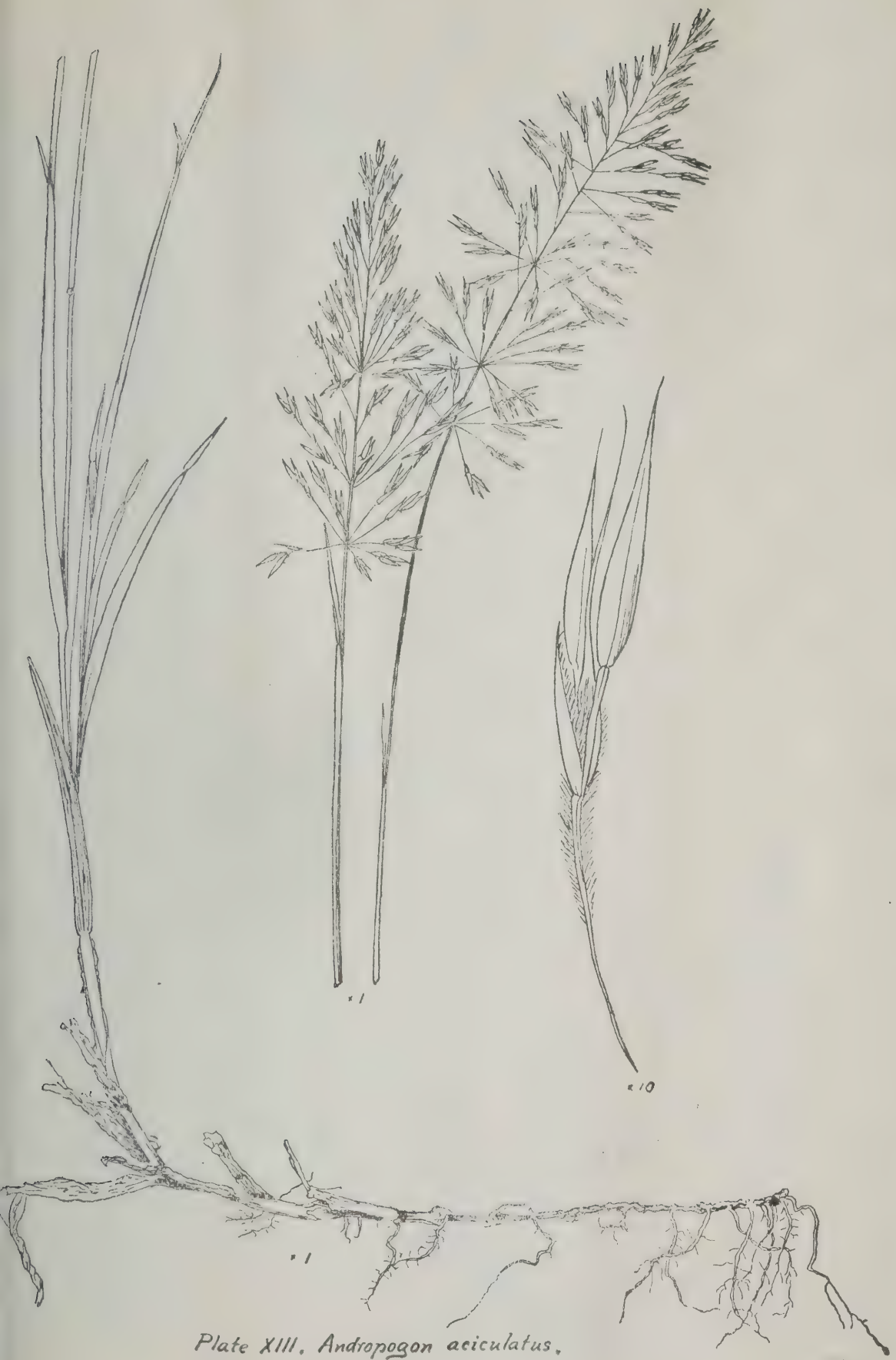

Plate XIII. Andropogon aciculatus.

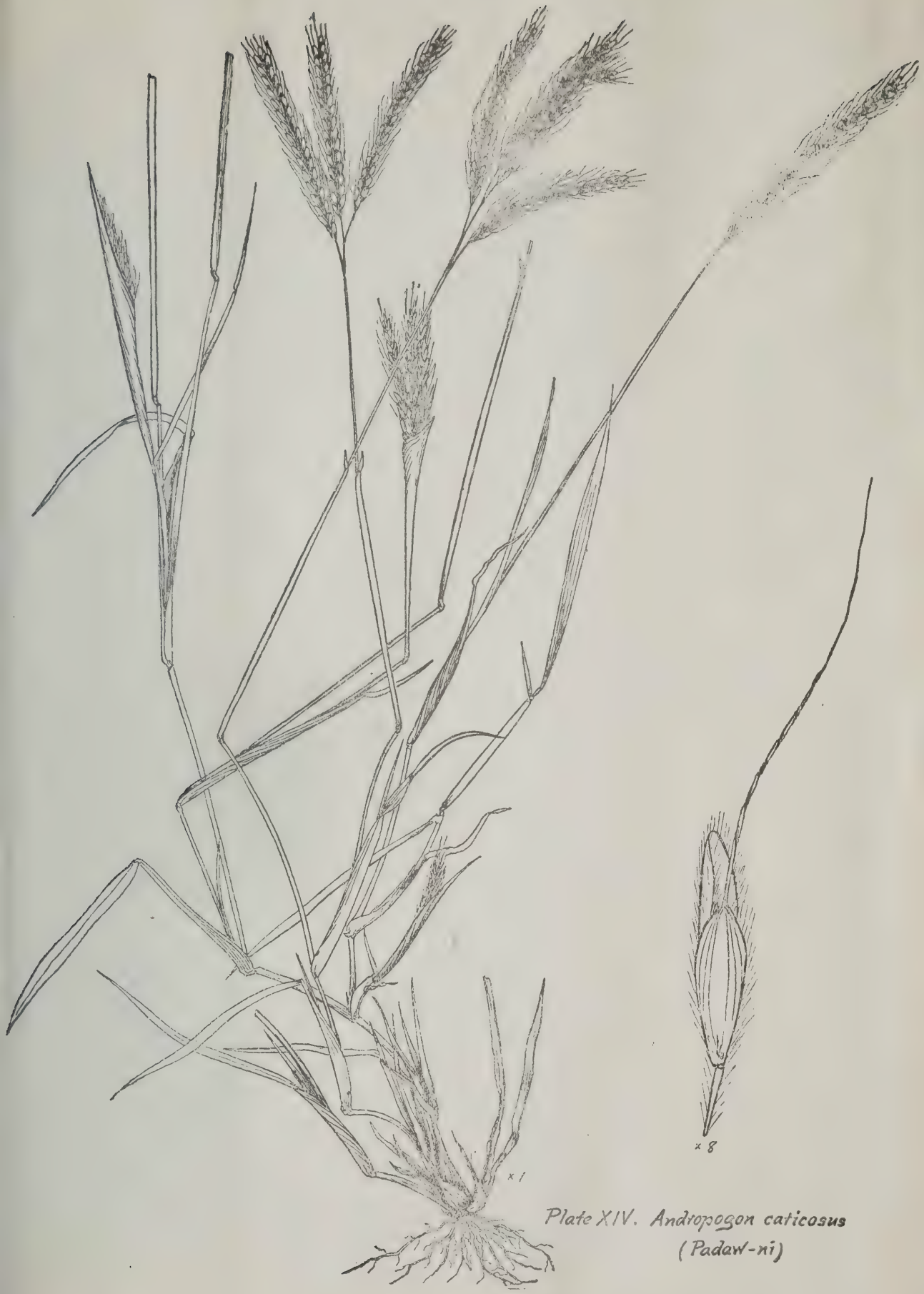

Plate XIV. Andropogon caticosus
(Padaw-ni)

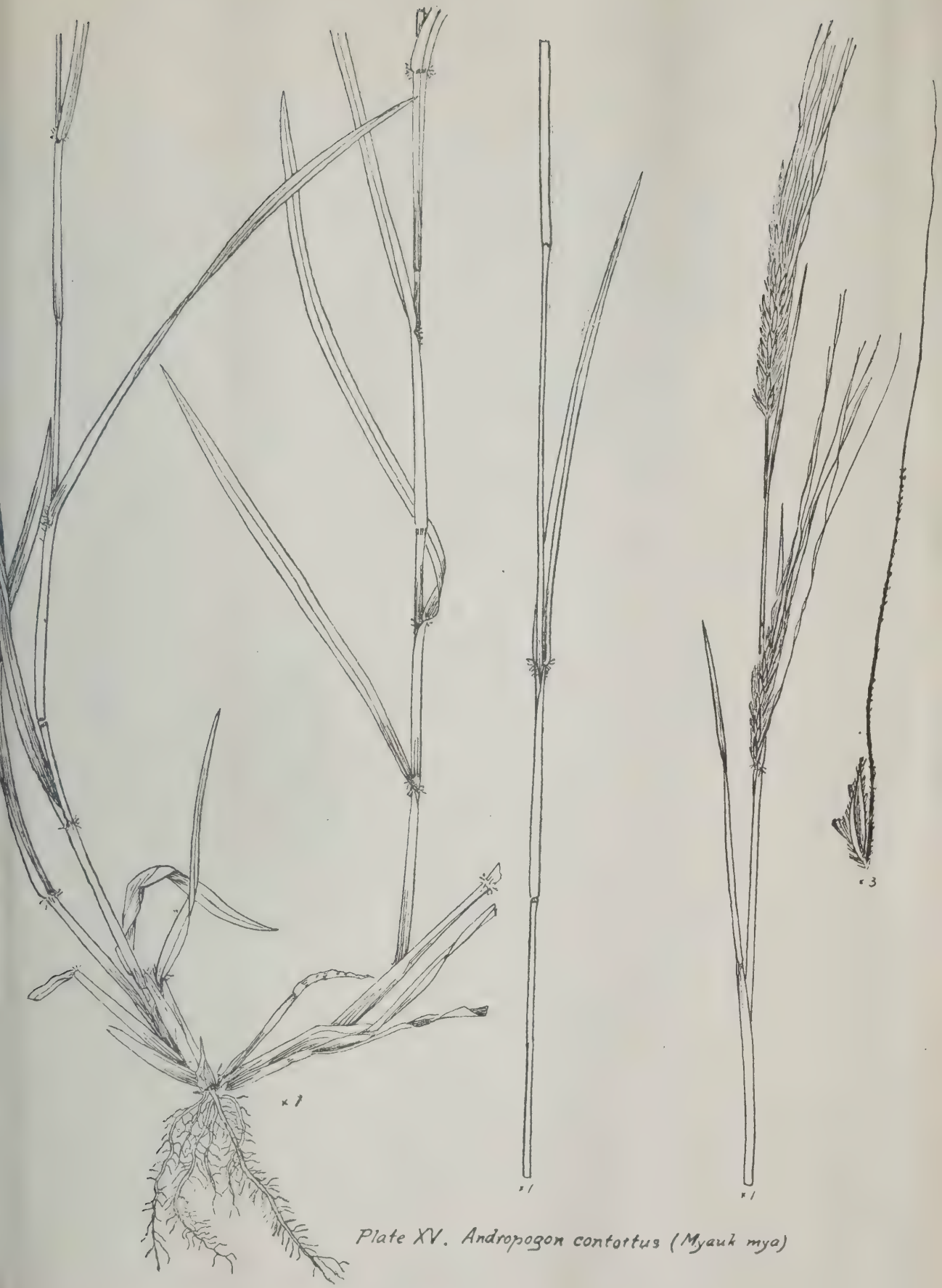

Plate XV. Andropogon contortus (Myauk mya)

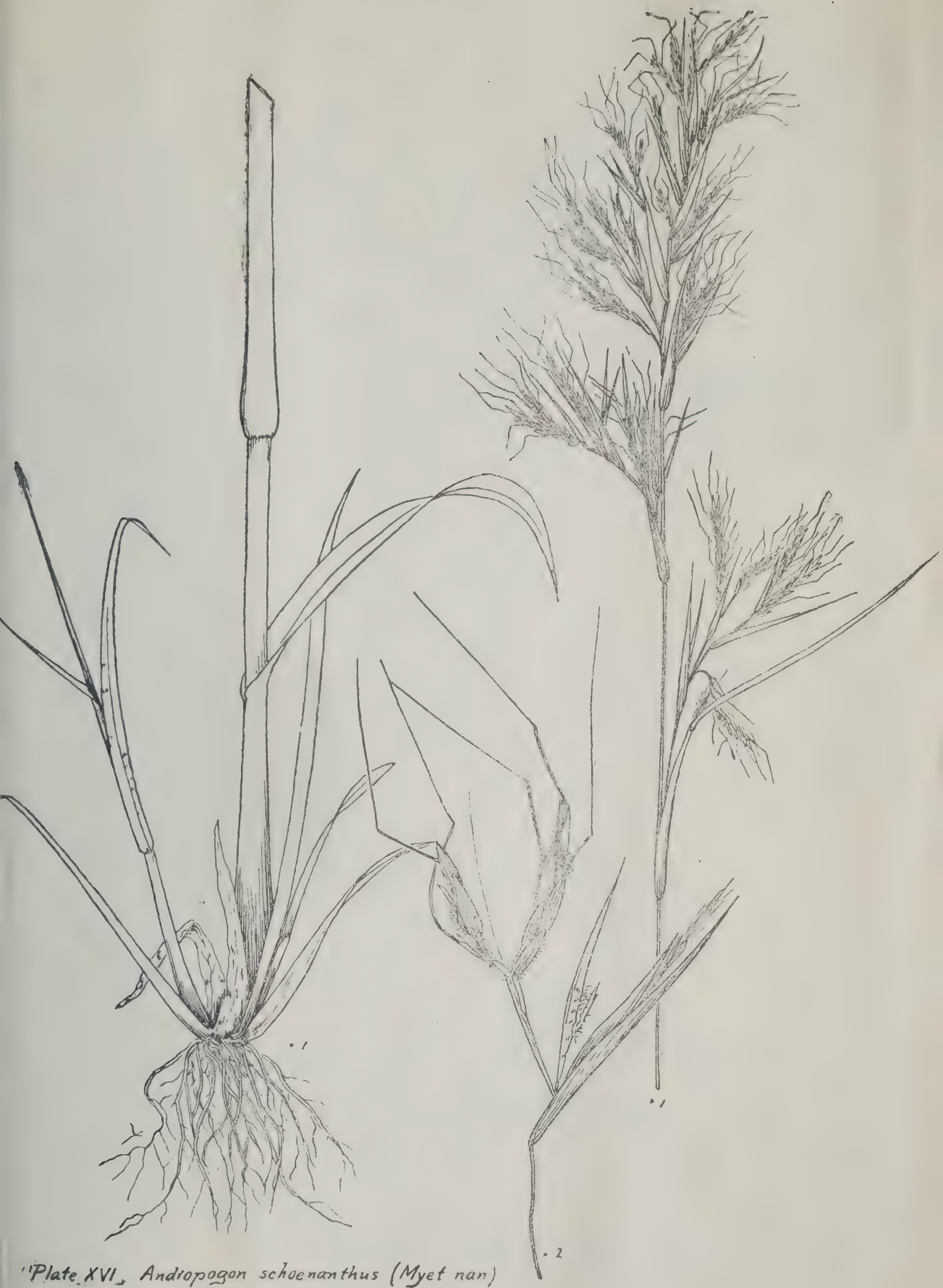

Plate XVI. Andropogon schoenanthus (Myet nan)

Plate XVII. Anthistiria ciliata (Myet swe hle)

Plate XVIII. Sporobolus coromandelianus
(Myêt-mòn-hmwa)

Plate XIX. Cynodon dactylon (Mye-so) or 'doob' grass

Plate XX. Eleusine indica (Sin-ngo-myet)

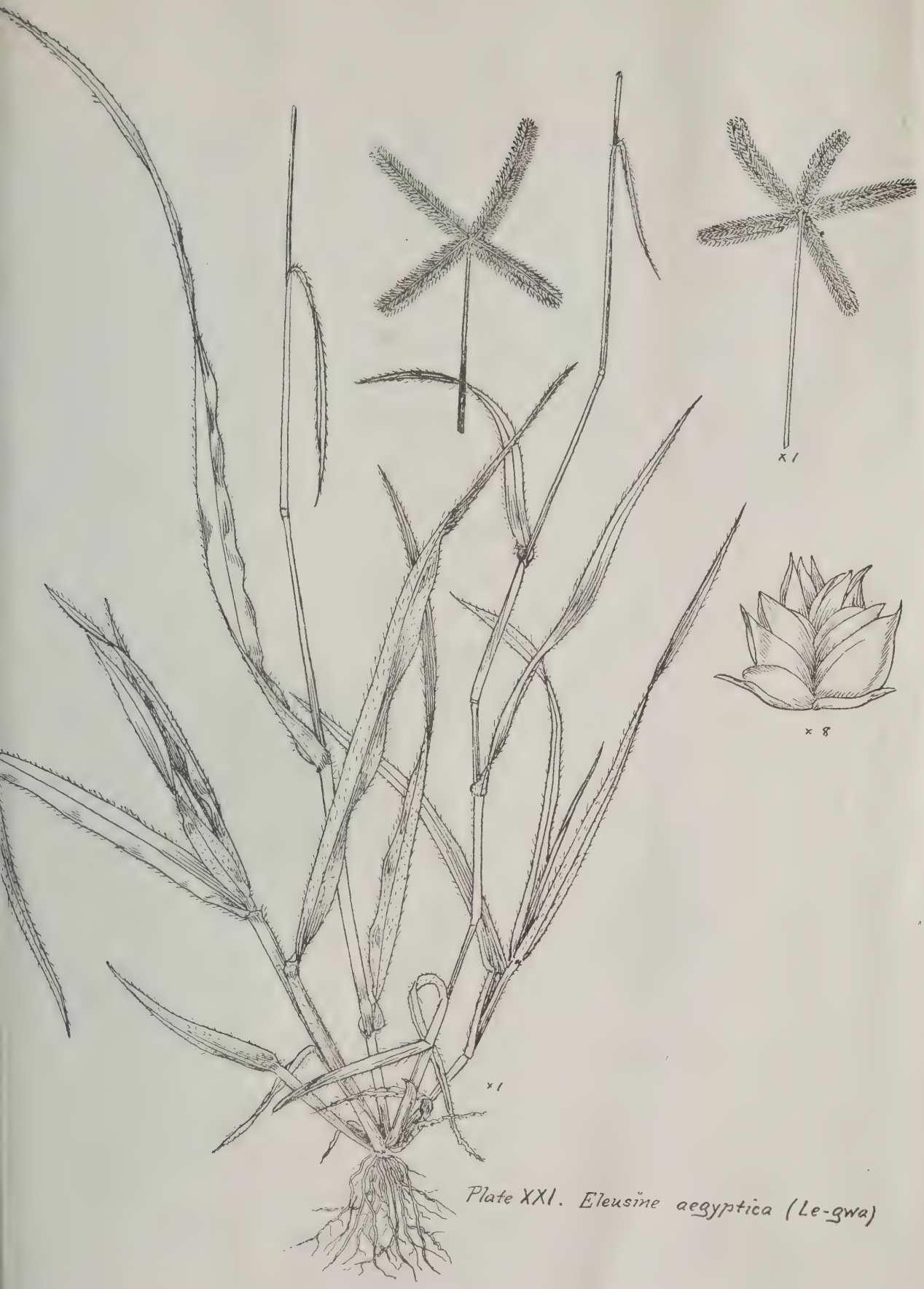

Plate XXI. Eleusine aegyptica (Le-gwa)

Plate XXII. Eragrostis tenella (Myet-mwa)

Plate XXIII. Eragrostis amabilis

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